History Behind Rohingya Influx in Bangladesh and Application of Remote Sensing in Monitoring Land Use Change in Refugee Driven Area

By
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Submitted in partial fulfilment of the degree of Masters of Sustainability

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June, 2020
I am the author of the thesis entitled “History Behind Rohingya Influx in Bangladesh and Application of Remote Sensing in Monitoring Land Use Change in Refugee Driven Area”.

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Shakin Rahman
Abstract

Approximately one million Rohingya refugees are given shelter on the land of Bangladesh since they fled away from Myanmar on 25th August 2017 in order to save their lives from being persecuted by their government. These large number of stateless persons are currently living in refugee camps of Ukhia and Teknaf upazila Bangladesh which has made it worlds one of the largest refugee camps. Remote sensing technique is widely used for monitoring the land use in many parts of the refugee settlements and this study finds that their presence on the host country has created a huge negative impact on their land use. Using the images from Landsat 8 satellite for different three years and conducting supervised classification has shown the decrease of forest land and increasement of settlement area in the study area. Forest land decreased by 11,609.36 square meter in 2018 and camp settlement increased by 6648.83 square meter in 2018. Moreover, analyzing NDVI in the study shows the subsidence of vegetation level on the refugee driven area as well. However, image analysis of 2020 says about the development of forest land and vegetation and secondary data clarifies the result due to policies adopted by the government and aid agencies. Eventually it depends on the diplomacy between two countries Bangladesh and Myanmar how this large refuge population can be sent back to their normal life.

Keywords: Rohingya refugees, remote sensing, land use change, vegetation, NDVI.
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<td>Area of Interest</td>
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<tr>
<td>DEM</td>
<td>Digital Elevation Model</td>
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<tr>
<td>FAO</td>
<td>Food and Agricultural Organization of UN</td>
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<td>OLI</td>
<td>Operational Land Imager</td>
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<td>IOM</td>
<td>International Organization of Migration</td>
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<td>IUCN</td>
<td>International Union for Conservation of Nature and Natural Resources</td>
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<td>ISCG</td>
<td>Inter Sector Coordination Group</td>
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<td>IDP</td>
<td>Internally Displaced Person</td>
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<td>Non-Governmental Organization</td>
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<td>NIR</td>
<td>Near Infrared band</td>
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<td>Normalized Difference Vegetation Index</td>
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Chapter 1: Introduction

1.1 Background:

It has been almost 30 years since the terminology “refugees” or “environmental refugees” is widely used by the researchers, academicians and policy makers (El-Hinnawi, 1985). Researchers have warned the world several times that 21st century would experience hundreds of thousands homeless and stateless people around the world who would be made compel to leave their country or it can be environmental causes as well (Castles, 2002). The significance of the displaced persons and forced migration in the world have brought the world leaders under the same umbrella two times in the United Nations Security Council (UN Security Council, 2011). Pressures were always upon the world as it was observing the stateless persons increasing day by day specially from the middle east due to persecution, mass killing and possession of the land (Chimni, 2009). It was predicted by Norman Myers in 1993 that the whole world would host about 150 million refugees (both environmental and forced displaced people) by the end of 21st century (Norman, 1993). There is much more uncertainty under the word refugee as it denotes the fear of loosing lives, loss of property, persecution and most importantly leaving their birth or living places and all these points were highlighted in the assembly of the world leaders at UN Convention, 1951. Moreover, refugees who are displaced due to environmental hazards are also been included though there is a significant difference between forced migration and climate migration. Environmental migrants can stay within their country boundary and most importantly their citizenship will not be snatched however, forced displaced people are made compel to leave their place and in most of the cases they become stateless which make them truly anonymous (Bahar, 2010).
The Rohingya community are a stateless, ethnic minority group who used to live in Rakhine state of Myanmar (known as Burma as well). Majority portion of Rohingya people follow the religion Islam though a small amount are Hindu and Christian (Gabaudan & Teff, 2014). The Rohingya community is regarded as one of the vastly persecuted group in this globe. From the beginning they struggled to uphold their fundamental right in their country since the Myanmar government never regard them as the citizen of their country (Lindblom, Marsh, Motala, & Munyan, 2015). It must be added that military of Myanmar and the extremist Buddhism followers has always triggered this persecution process upon Rohingyas and influenced the Myanmar government. This ethnic group have always faced extreme military action against them and spread out propaganda through campaigns. Going through the history lines for last 100 years, Rohingya people experienced several attacks in several years. This process began in 1970, then in 1991-1992, 2012, 2015 and most recently in 2017 (Leider, 2018). The persecution occurred in 2017 which caused almost 700,000 people flee to their neighboring country Bangladesh (UNHCR, 2019). (Lindblom, Marsh, Motala, & Munyan, 2015) stated that Myanmar government introduced their nationality law in 1982, which completely snatched the citizenship status from them. After law was passed in the cabinet, officially the Rohingya people became stateless and eventually the military oppression made them run away from the Rakhine state and compel them to take shelter in the Bangladeshi land.

The level of persecution was so intolerable that women, children, aged people no one was free from it which include extreme military ferocity, cruelty against women (mental and physical both e.g. raping case), deterioration of houses, villages moreover, compel women to stop giving birth new children by taking contraceptives (Ali, 2019). United Nations and other international
humanitarian agencies have always regarded this incident as genocide while Myanmar has always denied this statement. It was reported that more than 168,000 Rohingya people have fled away from Myanmar since 2012 in search for shelter however mostly in the closest neighboring country Bangladesh (Tan, 2017). (Human Right Watch, 2020) reported that since 1990s, the Rohingya people continued entering into Bangladesh and started living as unregistered refugees as Bangladesh government has declared them as stateless since 1992. This stateless status has dragged them into uncertainty and most importantly this is a burden for a developing country like Bangladesh. Demolishing of natural resources and environmental degradation are one of the major concerns for the host country. Moreover, undocumented increase of population can be matter of concern for Bangladesh as all have relation with limited natural resources and displaced persons must provide the basic needs as well. It was 25th of August 2017 when the Rohingya people began to flee from their own country crossing the river Naf and it was estimated that about 742,000 Rohingya entered in Bangladesh in that time (UNHCR, 2019). Though on October 24, 2017 both countries Bangladesh and Myanmar began official meeting for possible negotiation for taking back the Rohingyas but eventually this attempt did not see the hope (Tan, 2017). This study aims to explore the history of Rohingya people and their existence in Myanmar moreover, the reason behind their migration to Bangladesh.

Remote sensing now a days has become really popular among the researchers, academicians and policy makers as it provides reliable information and allows to adapt swift decisions in order to response in the emergency situations like natural disasters and humanitarian assistance (Lang, et al., 2015). Using this technology becomes really feasible when field data collection or verification is not easy or possible due to limitation of budget, time and to some extent security issues as
well. Using satellite images in humanitarian operations are widely used by the renowned organizations. In this regard, from short term to long term information are needed on displaced people and household data can be recuperated through high resolution (VHR) optical data (Tiede, Krafft, Füreder, & Lang, 2017). Moreover, satellite image can provide you the further information on natural resources (e.g. ground water level assessment), land slide prediction and impact on environment on the land due to having displaced persons (Hagenlocher, Lang, & Tiede, 2012). In humanitarian operations these satellite images not only helps in getting historical data, but also accelerate the monitoring and evaluation tasks in order to take disaster preparedness actions, awareness increasing among the refugees and risk adaptation strategies for future events (MuminBello & Aina, 2014).

This study uses the remote sensing technology to assess the land cover change for giving shelter to a large number of Rohingya people who are forcibly displaced from their country Myanmar to Cox’s Bazar, very close to the Burma border. It was reported that that influx brought more than 700,000 people after 25th August 2017 and it causes the expansion of Kutupalang refugee camp in Ukhiya and Nayapara refugee camp in Teknaf upazila. It results an extreme deforestation and natural resources extractions by the refugees along with local people (UNDP, 2018). Many organization have published their reports however, the most comprehensive report was provided by United Nation Development Program in 2018 (UNDP, 2018). At Nayapara refugee camp which is located in Teknaf upazila, a reservoir exists there named “Teknaf Wildlife Sanctuary” which is considered one of the reserved forests in Bangladesh (IUCN, 2011) was also effected by the refugees. One of the major reasons was collecting fuel wood and bamboo due to cooking purpose and shelter building.
1.2 Statement of problem

Refugees community are one of the concerning groups around the world and their presence on the host lands are a great threat for the environment and existing natural resources. Since 1970, Rohingyas the ethnic minority group of Myanmar are facing extreme difficulties in their country persecuted by their government, military and extreme Buddhism followers (Lindblom, Marsh, Motala, & Munyan, 2015). Earlier the Rohingyas came to their neighboring country Bangladesh as refugee in a small number (Tan, 2017) however, as a consequences of unmeasured repression-oppression for hundreds of years, more than 700,000 Rohingya people entered in Bangladesh in one tide on August 25, 2017 (UNDP, 2018).

It was truly very challenging for Bangladesh government to give them shelter to this extraordinary number Rohingya refugees on their land where this country itself is a developing country with limited natural resources (Milton, et al., 2017). The river Naf connects the two countries Bangladesh and Myanmar and most of the refugees came through this river. The district where this large number of Rohingyas are given shelter is Cox’s bazar, Bangladesh where they have the world’s largest sea beach (120 km), Teknaf Wild life Sanctuary which is declared as one of the reserve forests in Bangladesh (IUCN, 2011), in a short distance from Cox’s Bazar Siant Martin Island which is full of natural resources (Ahammed, 2010). So undoubtedly there will be an adverse impact on environment and existing natural resources.

It is never been an easy task to facilitate about one million refugees with their basic needs. Preparing shelters and toilets need wood, for cooking purpose need fuel wood which are the top most resources that are extracted from the host land. To fulfil this demand forest land and wood were cut which has a extreme adverse impact on the nature and directly or indirectly local
community is also affected through this deforestation. Moreover, it effects the ecosystem procedure where birds-animals are also correlated. In depth analysis can give a more actual scenario about the environmental degradation.

Remote sensing is widely used around the globe in humanitarian operations to assess the environmental degradation and for future decision making (Gandhi, Thummalu, Parthiban, & Christy, 2015). Analyzing the high resolution satellite images in remote sensing provides such results that help in future decision making, gives the current scenario that tells the depth of environmental decay and so many deterioration occurring in environment (Hegazy & Kaloop, 2015). This study will try to show the difference in land cover taking the satellite images from different years. The time of the images will be taken at least before the Rohingya people came in Bangladesh and another image will be after their entrance. Thus we will be able to see the what was the land cover before their entry and what’s the current situation. Remote sensing is such helpful in this regard and that’s why this technique is adopted by the researchers, academicians and policy makers.

1.3 Objective of the study

This study contains three objectives, and these are stated below:

- To assess the land cover change due to Rohingya displaced persons in the host area.
- To analyses the vegetation level of the study area through implementing NDVI (Normalized Difference Vegetation Index).
- To relate land-use changes to actual and possible policy measures to manage the refugee situation
1.4 Expected Outcome

In this study, expected outcomes are defined through achieving objectives. Expected outcomes are stated below:

1. Expected to gain knowledge on origin of Rohingya in Rakhine state, reason behind the outrage of Myanmar government, military and extreme Buddhists.

2. The persecution occurred in different years and its consequences.

3. Assessing the land cover change using remote sensing after the Rohingyas fleeing to Bangladesh.

4. Calculating NDVI will determine the vegetation and green density of the refugee sheltered area.
Chapter 2: Study Area

Cox’s Bazar is a district located in the eastern-southern part of Bangladesh lies in Chittagong division comprising 2,491.85 square km consisted with low lying coastal areas, agricultural lands and forested hill areas (Lewis, 2018). Cox’s Bazar town (locally known as Sadar) is situated on the west shore facing direct to Bay of Bengal. The geographic location of the study area is basically in the tropical monsoon zone due to it’s geographical location which causes heavy rainfall (on an average 4,285 mm annually) and high temperature in the dry season (Bangladesh Bureau of Statistics, 2016). Almost every year the district faces natural disasters such as floods, cyclones, tidal bores which eventually results environmental degradation, deforestation, loss of property, infrastructures and most importantly human lives (Lewis, 2018). As Cox’s bazar has the world’s largest sea beach which makes it one of the tourist attractions and it causes burden on it’s land and it’s limited resources (Ahammed , 2010). In addition, most recently giving shelter to almost one million Rohingya refugees has a huge adverse impact on it’s land and environment which to many extents local people are suffering. (Lewis, 2018) stated that basically the local economy of the study area is tourism and hospitalized based along with fishing, aqua fishing and small agriculture businesses. Considering the majority portion, there are muslims with other religion (Hindu, Christians and few ethnic groups). In Cox’s Bazar, indigenous tribal groups live in the locally hilly areas for last 45 years (World Bank, 2008).
The Rohingya refugee shelters are situated at various sites around Cox’s Bazar district. When the Rohingyas started coming in Bangladesh on 25th of August 2017, Bangladesh government expected political and diplomatic solution through pressurizing upon Myanmar that they took

Figure 1: Map of Cox’s Bazar District
back their people to their country however, nothing happened like that. And the result is almost 1 million refugees in Ukhia and Teknaf refugee camps (UNHCR, 2019). Though in the end Bangladesh government was overwhelmed by the international aid agencies (e.g. UNHCR, UNICEF, International Organization of Migration), NGOs which has made the humanitarian operation.

Basically in Cox’s Bazar, humanitarian operations are mainly operated in two sites named “Kutupalong refugee camp” in Ukhiya upazila and another one is located in south part of Teknaf upazila named “Nayapara Refugee Camp (OCHA, 2019). Kutupalang camp have expanded unexpectedly since the Rohingya started coming from Myanmar crossing the Naf river in 2017 August (Judah, 2017). Currently these refugee camps are hosting almost one million Rohingyas which was 742,000 in 2017 (UNHCR, 2019). However, considering the recent news of March 2019, Bangladesh is hosting over 909,000 displaced persons residing in Ukhiya and teknaf upazila of Cox’s Bazar, Bangladesh (OCHA, 2019). Among these numbers, majority refugees live in 34 extremely crowded camps which included the largest shelter site, the Kutupalang-Balukhali camp which is hosting almost 626,500 Rohingya refugees.
Chapter 3: Literature Review

Literature review gives a solid structure for building frameworks in order to conducting research (Creswell, Hanson, Plano, & Morales, 2007). It helps to explore and evaluates what exactly has been done on that research field. The Rohingyas who are leading an extremely miserable life at the refugee camps of Coxsbazar, Bangladesh after being persecuted from their country Myanmar and their presence has caused a significant environmental impact (e.g. land cover change) on the host community. For further understanding about the terminology refugees and the Rohingya influx in Bangladesh and furthermore assessing the environmental degradation, an in-depth study is necessary.

3. Definitions of relevant terms and concepts

3.1 Who are the refugees?

The worldwide used terminology “refugee” has evolved from the Latin word “refugium” and first used in France (refugie) which refers to the Huguenots; which indicates towards few number of French objectors who flee to other countries in order to save their lives after a religious law introduced in 1685. (Merriam Webster, 2016). The former Secretary-General of United Nations (UN) Kofi Anan stated that no one can experience such pain except those who are forcibly displaced from their living places (Ullah, 2011). Refugee issue has always been a concerning issue in the world politics and assemblies. The 1951 Refugee Convention by United Nations and 1967 protocol defines a refugee as who are made compel to elude their nearest or native countries crossing the international border due to persecution, social threat and war. Statelessness a curse which not let a person to grab the right of his/her country. A person can lead a miserable life
without being with family members however, statelessness will not give him any right, life security or protection and hardly any opportunities for him to survive (Tawodzera, Chikanda, Crush, & Tengeh, 2015).

The law of the modern era says about the refugees that the people who have no choice left but to leave their birth place (Lister, 2012). The reason behind leaving the place can be various (e.g. political conflict, cultural and religious rivalry, fleeing from being persecuted). (Lister, 2012) stated that a person will be regarded as a refugee who flees to his/her closest or most neighboring countries to save him/herself from being die and persecution. The world is now hosting a record number of refugees around the world. According to the present statistics 25.4 million people are refugees now a days. (UNHCR, 2018). This data gives the proof about the extreme level of violation is occurring in the world which is truly inhuman. As we all know people from Syria, Myanmar, Yemen and few other countries are facing extreme persecution which is causing the high number of refugees in the world. UNHCR reported that, almost half of the people are below eighteen years of age among 25.4 million total refugees.

3.2 Difference between Refugees and Migrants

The worldwide used words “refugee” and “migrant” serves different meanings. (Zetter, 1991) said that a refugee is made compel to leave his country, however a migrant can take decision to move elsewhere. A migrant can forcefully leave but reasons can be bit different like poverty, climatic calamities, even though the person will get the health and life protection from his country and most importantly his citizenship can not be denied. However, the exact opposite happens with a refugee. According to (UN Refugee Agency, 2011), which defines the legal definition of refugee and migrant which was signed by 145 countries in 1951 Refugee Convention
and from this convention the actual definition of refugee was for the first time introduced. In this convention all the delegates come to an agreement on the definition of a refugee that a person who is outside of his country due to having fear of persecution, religious views or political counsel and unable to go back to his country will be regarded as a refugee, whereas a migrant will not have the fear of returning home in the end and they will get moral and basic supports from their government. A migration can be two different types (i.e. Long-term migration and short-term migration) (International Organization of Migration, 2011). The UN Migration organization defines the short-term migration period for three to twelve months, where long term migration can be for more than one year and to some extent it can be for good as well.

3.3 Host Community

Host community defines a country who let the asylum seekers to stay but not permanently. (Brick, et al., 2015) defined host community as an independent country or nation which ethically or under compulsion let asylum seekers enter into their country and permits them to reside for a certain period or long-term basis on their land.

Host community can be welcoming towards the asylum seekers and give access them to use and share their natural resources (ARRA, 2011). However, these accesses can have adverse impact on the host country due to limited resources, misuse of the assets and natural resources and on environment, local economy and social life as well (Pérez & Nadal, 2005). It can difficult for the host country to facilitate them with all basic needs but in this case international aid agencies come forward to run operation along with the host government. Bangladesh can be perfect example in this regard as they are hosting almost one million refuges on it’s land fleeing from Myanmar.
3.4 History of Rohingya community

Rohingya people grab the government’s interest in the late 1950s and from then it started spreading rapidly news on human rights violations more specifically against Muslims in North Rakhine State when it was 1990s, and then again after in 2012 same violation occurred (Leider, 2018). In 2018, the author also stated that during the second world war, the regional muslims for the first time claimed the recognition for them in Myanmar and it was the beginning of Rohingya ethnonationalist movement. In order to explore the history behind claiming distinctive identity of Rohingyas, citizenship rights and Muslim-Buddhist conflicts, we must go through the roles of muslims in Arakan kingdom and contribution of their population during the colonial period.

The terminology *Rohingya* indicates an ethnoreligious identity of Muslims in North Rakhine State, Myanmar which is formerly known as Burma. Burma is one of the most ethnically diversified countries in the world with more than hundred languages and almost about 55 million of population (Smith, 2007). This country always had a good opportunity to be a prosperous one in Asia however instable political situation and huge number of ethnic groups and their clash has never let the country’s economy going upwards (Ashley, 2008). Traditionally Myanmar has a rich history where they are known as “Rice Bowl of Asia” but internal political clash, absence of international funding, external investment has taken it’s economy downward day by day (Ganesan & Hlaing, 2007). The politics of Myanmar has always been surrounded with two issues: establishing democracy in the country against military government and battle for endemic minority rights. As a consequences Myanmar was listed as *Least Developed Country* by United Nations (UN) since 1987 (Smith, 2007). It’s history says that Myanmar had gone through few conflicts several times with different ethnic groups like Shan, Kachin, Karen) whose main
determination were seeking political right where as Rohingya issue was totally unique as their issue was on core statelessness. While the other ethnic groups had political and democracy issue, the Rohingya struggled with the fundamental rights as citizens of the country (Kipgen, 2013).

The location of the Rakhine state is between South Asia and South-East Asia which has made it a “frontier culture” for the Muslim and Buddhist communities. (Bahar, 2010). Bahar in 2010 also stated that Rakhine state had the Indic influence from the ninth century to 1785 when the Burmans conquered the region. Rakhine state was mostly lived by the muslims and culturally similar with the neighboring country Bangladesh ( Ganesan & Hlaing, 2007). Historically the people of this region kept crossing the ambiguous border in a regular basis in the Myanmar’s pre-colonial period.

The Rohingya people and the place they live in the Rakhine state, both have difference in language, religion, culture and heritage. Inspite of sharing the same territory since the 8th century, these differences were always considered while judging them as citizens, eventually which resulted in significant adversity between these ethnic groups (Card, 2005). The Rohingyas were the ancestors of Arab muslims traders who came over land and sea routes in order to settle themselves in Rakhine state in the early seventh century. Culturally they have the similarity with south Asian people specially with the Bengali people (Perlez, 2014). Most of the Rohingya follow Islam as their religion. It is must to keep in mind that the word Rohingya is a controversial term in Myanmar. The people of this community regard themselves as Rohingya and it is also commonly used by the international communities to regard them, however the majority of local Myanmar refer them as illegal migrants who have come from the neighboring country Bangladesh. The history says that the Rohingyas are living in Rakhine state for many centuries
where it is documented that they are here since 1799 (Kristof, 2014). Kristof (2014) also added that according to a report published in 1826, about 30% of the total population were Muslim in this region. From the very beginning of 1960, the Rohingya people were always under harassment by the state government of Burma. As a result, since then in 1970s, the Rohingya refugees and migrants started migrating to Bangladesh, India, the Middle East countries and South-East Asian countries, consisting a formal body of Rohingya community that can represent their existence and demands in front of the world through political and cultural platforms (Mukul, et al., 2019).

Generally, there are so many minor ethnic groups live in Rakhine state of Myanmar who practiced “Theravada Buddhism” and use such a language which has mostly similarity with Burmese. Buddhism which is the most vital attribute that defines a citizen of Burma and that’s the thing which has given the shelter to the other indigenous ethnic groups in Rakhine state which is officially 135 over the Rohingyas (Kipgen, 2013). In the early 14th century, the Rakhine state was manipulated by the Muslim Sultanate extensively that the Buddhist leaders started adopting muslim names. During this time, Buddhist kings also ruled the Rakhine state however even muslims played a significant role in both defense and administration that time of the kingdom (Siddiqui, 2008). In that time mosques were built all over the countryside and Islamic culture had a good influence over the society.

3.5 Origin of conflict between Buddhist and Muslims

The conflict of Muslims and Buddhists was originated in the colonial period under the British ruling period from 1826-1948, which eventually destabilized the precolonial society of the country. In the post British ruling period, Buddhism spread all over the country that it started influencing every aspect of the society. In the educational institutions’ Buddhism was taught
rapidly. Gradually the Monks became the most respected person all over the society besides they were involved in the administration works as well. Even the Monks got appointed by the administration to provide advice to the king in ruling the country (Steinberg, 2013). Basically, the British colonial period was comparatively short however their ideology had great impact on the ethnic relationships which consequences were huge. During this time, strong opinionated activists raised which gradually welcome the remnant foreign domination. Very few policies were introduced by the British and these were: They removed the position of “thathanabaing” which means the senior monk who actually misused the religion through administrative activities and tarnished the religion. Second thing the colonial rulers conducted was made the entry of Christian missionaries in Myanmar. This policy introduced divisions in Myanmar culture and decayed the ideology of Buddhism. Lastly, they brought western education system in the educational institutions which completely flicked the cultural dividers from those who had still faith on Buddhism and who accepted the western education system (Steinberg, 2013). According to David Steinberg in the period of British colonialism western education became one of the major indicators for economic success.

Considering the present time, Myanmar’s xenophobia can be best described through opponency of Christian missionaries by the Burman society in the colonial period. The Buddhists believe that refusing the practice of core Buddhism means a Burman has converted into disloyal citizen of the country. Besides it was also regarded that by becoming a disloyal citizen, the person has lost his nationality and will be regarded as a foreigner (Gravers, 1999).

Myanmar was ruled as a province of India by the British ruler until 1937 inspite of having cultural differences between two countries (Steinberg, 2013). Later on, the British also divided Myanmar
into two administration sections (e.g. valleys of south Burma and mountainous north Burma) considering cultural and political issues. The southern valley was named “Ministerial Burma” which was actually administrated as a part of India however the northern part was completely administered by the British governor (Gravers, 1999). (Steinberg, 2013) stated that according to many Burmans, this policy named “divide and rule” was the key reason for the conflict between ethnic minority groups that the world is witnessing in the present day. As southern part of Burma was administered by India, the British misused this chance to let the Indians enter into Myanmar as workers, soldiers, laborers and money lenders. By the end of the second world war, almost half population of Rangoon became Indians and the British started appointing Indians and Christians for works over Burmans. Thus the anxiousness grew among the local people and news came in the newspapers and electronic media in 1930’s that marriage between different region and religions (Indian hindus or muslims with Burman women) would make the women forced to follow Buddhism in order to sustain in their country (Gravers, 1999).

3.6 Rohingya community

The ancestors of Rohingya settled themselves in Rakhine state in the early 8th century and they belonged to Islam religion moreover, their physical appearance were closely similar to the neighboring country Bangladeshi people (Siddiqui, 2008). In between 1920s and 1930s, the Buddhist leaders began integrating xenophobic slogans in their public assembly raising voice against colonial rule. In this case, the first attempt by the Burmans against British rule came in front in 1885 which was powered by the Young Men’s Buddhist Association (YMBA) (Gabaudan & Teff, 2014). This association was formed to stand against Christian dominancy in Burma’s politics. Though they formed this association as an inoffensive boycott movement, but gradually
this organization turn into more intrinsic. One of the main agendas of YMBA was to expand Buddhism all over the Burma (Kristof, 2014).

After the world war II, situation started changing in Myanmar which accelerated the acridity of ethnic tensions (Mahmood, Wroe, Fuller, & Leaning, 2017). At the end of the war, the leader of Burma Independence Army (BIA) of that time Aung San took the initiative to reunite the people of minority ethnic groups (Kipgen, 2013). Aung San hold the support for the ethnic minority and worked with Burmese leaders to form a western model for the federal state including the representative from the minority group. The model was established in 1947, on February 12 with the signature of Panlong agreement. However, before this agreement saw the light of hope, Aung San along with his entire team was assassinated in July of that following year 1947 (Bahar, 2010).

Just after the death of Aung San, in the next year Myanmar officially achieved independence in 1948 from the British regime and U Nu became the first prime minister of independent Burma (Steinberg, 2013). In that time, Rohingya people were treated as the citizen of the country (Siddiqui, 2008). Moreover, Rakhine state had autonomous administration body under union of Burma and the government had two Muslim members of parliament as representatives (Parinini, 2013).

3.7 Martial Coup in Burma

In 1962, General Ne Win did a military coup, which eventually turn into tyrannical military rule for the Rohingya (Parinini, 2013). When the martial law took place, since then there was no single Muslim representative in the Myanmar parliament (Siddiqui, 2008). (Siddiqui, 2008) said that in 1962, Rakhine state’s autonomy was extinct and the “Military Janta” took over all the charges of financial institutions and businesses and made it nationalized. Since then Rohingya people were
deprive of their political right. The military government started spreading that this martial law would be for the betterment of the Burmans as it would protect their citizen’s right from the minor ethnic communities and foreigners and not let them take over the country power (Gaubaudan & Teff, 2014).

3.8 Beginning of discrimination against Rohingya

The discrimination against Rohingya started in 1962 and eventually the final policy to exclude them constitutionally was the “Citizenship Act 1982” (Blakemore, Who are the Rohingya people?, 2018). This act also kept them away from participating in politics. Blakemore (2018) also said that the Burman authority did this because they always thought the Rohingyas as the immigrants from Bangladesh.

The first attempt of carnage towards Rohingyas held in February 1978 when the Myanmar military (locally known as Tatmadaw) introduced a new program in their country titled “Nagamin” (Dragon King) to conduct a census of the whole nation (Ullah, 2011). The result of this census project was rape, mass killing, banishment of Rohingya from their land. The report says that about ten thousand Rohingya were killed, moreover 2,00,000 Rohingya were made compel to flee to Bangladesh (Parinini, 2013). The Myanmar army circulated this massacre conducted by “Armed Bands of Bengalis” and few muslims extremist rubbing Buddhist society. After all these injustices, The Rohingyas again got the permission to go back to their villages but strictly under tight observation by the Burmese authority (Smith, 2007). According to the the citizenship act 1982, Burma had only 135 national groups before 1823 and only these certain groups would get the citizenship of Myanmar where Rohingya could not include themselves among those 135 ethnic groups (Staples, 2012). By implementing the citizenship law in Myanmar, Rohingya ethnic
group became one of the largest stateless group in the world. About 800,000 Rohingya live near Myanmar border and more than 50% flee to live in their neighboring country (e.g. Bangladesh, Malaysia and Thailand) (The Economist, 2014). Considering the present data of the world, almost 711,336 people from Rakhine state had runaway to Bangladesh after 25th of August, 2017 (UNHCR, 2018).

3.9 Second Massacre on Rohingya

The second massacre on Rohingya occurred in 1991 which made 260,000 Rohingya to flee to Bangladesh. (Staples, 2012). In the following time, the Myanmar government introduced the reformation of government, moreover, opening the economy for external investment. However, taking this step heightened the international attention took place in Rakhine state with the Rohingyas. In 1991, United Nation (UN), in its annual assembly reproached the whole situation happened in Rakhine state with Rohingyas (Smith, 2007).

Considering the massive repercussion, the UN High Commissioner for Refugees (UNHCR) took initiative to repatriate almost 200,000 Rohingya again in Myanmar from 1992-1999 (UNHCR, 2018). But this initiative did not work properly, and thousands of refugees kept fleeing to Bangladesh throughout the decade. Coming in 1992, Myanmar signed a (Memorandum of Understanding (MoU) with Bangladesh, agreed to bring back the Rohingyas who could proof their residency of their country. However, Burman government kept denying their existence (Staples, 2012).

Since 1962, the point of view of Burmese Military government for the Rohingya was very baleful. The leader of the Rakhine ethnic group’s leader had always stated that they were always treated as foreigners in their own country (Bahar, 2010). The racial problem in Burma was always in the
front line even it was with their identification name as well. The Buddhist or Muslims both group regard one other as Buddhist-Magh (*Bandit*) and Muslima Kaka (*foreigner*) (Smith, 2007).

### 3.10 What is international human security?

From the year 2000, in every aspect of life the Rohingyas were deprived off their fundamental rights as a citizen, moreover they had to struggle with hunger, restraint, diseases and physical abuse (Leider, 2018). Being a human, it’s someone’s elementary right to get the life security and live with dignity. None of these was in their fortune. Such issues never remain in national issues where a large community is in life threat and ethnic disputes take place, it converts into international issue.

United Nation Development Program (UNDP, 2012) defines human security as all general people will have the access to move safely and freely and trust on government that their right will not be diminished. Human security has two aspects. First one is protection from chronic threats such as hunger, oppression and any kind of disorders. Second one is safety from all types of life threats which hinders daily life (e.g. job security) (Human Development Report, 1994). Considering all of the above the Rohingyas were always under insecurity for not having the citizenship of their country. However, this is very vital for a person to hold a citizenship status of a country in order to fully exercise the social, political, economic and civic rights within a states territory and a residency status helps one to receive protection both domestically and internationally (Weissbrodt & Collins, 2006).
3.11 Persecution against Rohingya from 2000-present time

For many decades’ persecution has taken place on many ethnic groups in Myanmar but the violation was targeted more specifically against Rohingya community group. Offense that had taken place during ethnic cleansing with Rohingyas include:

“Murder, physical torture, arresting men, sexual harassment, raping, destructions of homes and buildings, monuments, starvation, ravaging and all kinds that can destroy a community.” (Blakemore, Who are the Rohingya people?, 2018). This persecution was conducted to make them compel flee to neighboring countries like Bangladesh, Thailand and Malaysia.

The citizenship act of 1982 has always exploded the rights of Rohingya community. They were mainly deprived of six essential categories declared by United Nations Development Programme among total seven which were economic, political, food, health, personal and community (UNDP, 2018). The Rohingya hardly got opportunity to participate in state government or federal politics (Kipgen, 2013).

3.11.1 Economic discrimination

The Rohingya community were always economically marginalized due to their stateless status. Economic security needs “assurance of basic income” generally from generative and remunerative works, if not operative then atleast financial safety net from government (King, 1998). It is worldwide recognized that the employer does not want to hire any undocumented employee and, in this issue, Rohingya hardly got scope to be employed. They have to rely on daily basis work which is very low payment to survive in the long run (Weissbrodt & Collins, 2006). For so many years, the Rohingya are leading their life under strict restrictions moreover, since 2012 government has imposed many checkpoints which they must go through and these
steps have made their access to any work more complicated and restricted (Gabaudan & Teff, 2014). Over burden of taxation policy had also made their life difficult as they had to pay from their very low income (Omi, 2011). The decoy of income and overall insecurity has kept them behind in accessing required food.

3.11.2 Food discrimination

Food security means when all the people have both physical and economic access to sufficient and nutritious food that is required to lead a safe and healthy life (FAO, 1996). However, having sufficiency of food can cause people to starvation if they can not afford or lose the ability to purchase food. Food security is always been a concerning issue in Myanmar. Deficiency of nutrition is a common phenomenon in Myanmar with about 35% infants who have been suffering from buying basic foods (e.g. rice) (Steinberg, 2013). For the minority in society, Rohingya community faced the discrimination considering food issue as well from the government. Specially the people who are living in internally displaced persons (IDP) camps refugee shelters since 2012, have faced extreme food insecurity (Ibrahim, 2015).

3.11.3 Health discrimination

Rohingya community has always got a very little health service in their country. Health security defines the causing of death due to malnutrition and unhygienic environment (e.g. polluted water which causes diarrhea) (Rushton, 2019). UNDP in their report published that third world countries or developing countries invest a very little for health service and most of the people can not afford to visit doctors (Bhatia, 2019).

The health care service is very vulnerable and to many extents Rohingyas are the victims. Myanmar government spends 0.5% of their total gross domestic product (GDP) for health care
services and required drugs are not available except for the wealthy and well-off citizens. Every year 700,000 malaria suffering cases, 130,000 tuberculosis cases, HIV patients approximately 350,000 cases are common in Myanmar (Steinberg, 2013). In these vulnerable health situation, Rohingya people even experienced worse as their access to medical facilities were denied (Weissbrodt & Collins, 2006). In the IDP camps, Rohingya faced extreme lacking of health facilities where there were unavoidable deaths. However, these deaths mostly occurred in pregnancy cases who faced birth complications (Htusan, 2014). As they had travel ban, so could not travel to visit doctor or health officer. In addition Myanmar government had exacerbated the restrictions to the humanitarian aid groups in the IDP camps who actually provide medical service and deliver foods to the Rohingyas (Motlagh, 2014).

Rohingya community experienced discrimination against them without any state security all over the Myanmar. The muslim Rohingya group faced it extremely due to their religion views and beliefs and in addition statelessness was common phenomenon (Ibrahim, 2015). In education sector they experienced the contraposition as well. The children of Rohingyas were not given access to take secondary education moreover, Myanmar government imposed restrictions on high school graduates that they can not travel outside the Rakhine state to attend colleges and universities for further studies (Kristof, 2014). The author also added that in order to get married and number of children they can take legally, the Rohingyas have to seek permission from government. They even could not attend, gather and celebrate the Islamic celebrations (e.g. *Ramadan month, Eid-ul-Fitr and Eid-ul-Azha*) and no permission for building mosques (Ripoll, 2017). The Myanmar government made the Rohingya society so vulnerable that they lost the ability to raise voice against the persecution.
3.12 Genocide on Rohingya in Myanmar

History says that Myanmar has always promoted ethnic cleansing in their country and Rohingyas are the main prey of them. Persecution and genocide both took place with the ethnic group, but it got the culmination in 2012 and from then it continues throughout the Rakhine state. This massacre led many scholars, academic researchers, legal experts and most importantly international organizations and NGOs to work and publish this atrocity occurred in Rakhine state (Khin, 2014). Intention to destroy a community or religious group in a whole or in a cluster can be regarded as genocide (Card, 2005). On the other hand, genocide is considered if three points are followed. These are as followed: killing general members of a group or community, make people mentally disable or destroyed and continuously embedding a specific group and make physically disrupted (Woolford, 2006).

The beginning of extreme violence between Rohingyas and other ethnic groups of Rakhine took place in June and October of 2012. Primarily the violence was triggered by a rape and murder case of a 28 years of age Rakhine lady on 28th May 2012 conducted by three muslim men (Ibrahim, 2015). Following the incident and to take revenge, on 3rd June 2012, a group of Rakhine men beat and killed 10 Muslims by stopping bus who were on board. Thus, both muslims and other non-muslim ethnic groups prepared mobs and started robbing and killing in both communities. However, there was no step taken by the state security agency of the government to solve the issue rather they joined and helped the Rakhine mass mobs in order to invasion and burn the house, villages and neighborhood of the muslims (Blakemore, Who are the Rohingya people?, 2018).
By the end of October, the opposition became much more malignant and organized against the Rohingyas. In the earlier months, local Rakhine political workers with the direct help of the monks, published campaigns containing statement that the Rohingyas are threat to the country (Gabaudan & Teff, 2014). A group of conscious Rohingya raised the voice against their persecution to the government as they were advised to prepare for leaving their villages. But day by day the situation got worse. On 23rd October 2012, thousands of non-muslim people from Arakan state attacked nine villages with muslim majority containing swords, local guns, other destructive arms (Kipgen, 2013). Human Rights Watch stated this as genocide and this persecution occurred simultaneously in the townships and kept taking place after certain period. Among all these incidents, extreme persecution took place in Yan Thei village where about 70 Rohingya were brutally killed including 28 children where 13 children’s age was below 5 (Ibrahim, 2015). According to the report published by (Human Rights Council, 2018), almost 180,000 people were directly affected by the violence of 2012. This incident made almost 140,000 people displaced where majority were Rohingya. A report published that in this incident almost 10,000 buildings and homes were completely damaged and destroyed (Motlagh, 2014).

The massacre that has taken place in Rakhine state clearly demonstrates that it has happened directly with the support of the state and federal government. Literatures also say the same that both killing and displacing are planned and well organized with the help of security agency and agents. Collective violence requires upper level support to conduct perpetrate in the field level that will break the human rights against ethnic minorities (Oberschall, 2007). It is proved in the research works that target groups are inhumanly treated and tortured moreover, no mercy on any one even for children and women group which is strictly prohibited in the international
human right law (Ashley, 2008). It can be undoubtedly said that government’s support has made the local non-muslim Rakhines specially the Buddhists more aggressive to serve animosity against muslim Rohingyas and in this consequences, destructive and inhuman persecution occurred in 1978, 1991, 2001, 2002, 2012 (Leider, 2018). Most recently what happened in Rakhine state in 2017 with Rohingyas is absolutely inhuman and brutal. The persecution occurred in 2017 made almost 742,000 Rohingya muslim flee to neighboring country Bangladesh (UNHCR, 2019). All over the Myanmar society the Buddhists have spread the Buddhism in such a way that general people are influenced to expunge all the outsiders or foreigners from their country. A movement titled “969 movement” is considered as the head of this step introduced by a monk named “Ashin Wirathu” (Marshall, 2013). Following the tumult occurred in 2012, the “969 movement” got the media coverage in “Time” Magazine with Ashin Wirathu’s picture on July 2013 titled as “The Face of Buddhist Terror” (Routray, 2013). The main philosophy of this movement was to establish anti-muslim attitude and protect Buddhism from non-native people.

There was in total 15 camps in IDP sites through out the Rakhine state mostly in the area of state capital Sittwe. However, there were huge deficiency of fundamental needs like drinking water, medical facilities and sanitation issues (Htusan, 2014). The federal government did not take steps to facilitate them in IDP camps and moreover, help them to return to their houses and villages or communities. Myanmar government-imposed restrictions on the international humanitarian organizations and it’s workers who were intend to run their operation in the affected area. Soon the government banned a NGO named “Medecins Sans Frontieres” in January 2014, whose work was to provide initial health service to the Rohingya victims as they started revealing the actual number of victims in the IDP camps (Leider, 2018). Since then the Buddhist officials and leaders
put pressure on government to let UN organizations and other NGOs go from Rakhine state (Gabaudan & Teff, 2014). Since there was not enough service and needs given to the Rohingyas moreover, they were not given permission to go out from the camps to buy food and other necessities from market which eventually caused extreme malnutrition specially for the children, pregnant women and aged persons (Mahmood, Wroe, Fuller, & Leaning, 2017). All these inhuman steps were intentionally done as the authority wanted them to morally disable. For the Rohingyas, they had no option to run away or go out from the camps except going through the brutality. The Rohingya people who were outside the IDP camps, government took few policies which would made them compel to fell to the nearest countries like Bangladesh, Thailand and Malaysia. According to the report published by Refugee international from October 2012 to July 2013, just to save lives, about 785 Rohingya submerged to sea in order to reach a safe place for them. The people who somehow survived and reached a place still facing problem due to stateless status though not that much worse like Rakhine state.

Bangladesh became the top in hosting the largest number of Rohingya refugees as it is the most closest neighboring country sharing the north-west border with Myanmar divided by Naf river (Pasley, 2019). According to the estimation of 2010, there was total 200,000-400,000 Rohingya refugees sheltered in Bangladesh (Ibrahim, 2015). However, in the following year there were only 28,000 refugees lived according to the official report under the supervision of Bangladesh government and UNHCR. Rest of the refugees were not under responsibility of UNHCR as Bangladesh suspended the refugee status for Rohingyas after 1993 (Bahar, 2010). Officially UNHCR operated only two refugee camps in Kutupalong and Nayapara in Cox’s Bazar district of Bangladesh (UNHCR, 2019).
3.13 Fleeing to Bangladesh

It is narrated earlier that the government of Myanmar and its military never acknowledged Rohingyas’ existence and continued persecution upon them. It was told that few Rohingya militants along with civilian attacked on border police in 2017 which caused 71 people death where 12 members were from security force (The Gurdian, 2017). After this incident the military became unsparing and started inhumane persecution including attenuation of houses, rape and arresting. Many people were killed, and it was claimed that genocide had occurred there (United Nations, 2018).

After the violence occurred in 2017, a massive wave of people started coming to Bangladesh in search for shelters. According to the data of 2018, August, almost 723,000 people came to Bangladesh in order to saving their lives (UNHCR, 2018). UNHCR (2018) also added that most the displaced people were women and children where about 40% were under 12 years of age. Most of the refugees are being sheltered at “Ktutupalong refugee camp” of Cox’s Bazar which is now the world’s largest refugee camp (Ali, 2019). But still they are at life risk as it is very difficult to accommodate around one million people. The UN agencies along UNHCR said that about 200,00 Rohingya are at risk due to monsoon season which can cause flood and landslides as well.

unsurprisingly, this refugee issue created adverse diplomatic relation between Bangladesh and Myanmar (Parinini, 2013). Since 2008, Bangladesh government became more strict in sending back the refugees who tried to come illegally. Gradually the diplomatic relation got more affected when Myanmar government decided to build a 200-kilometer fence along the border with Bangladesh. The reason behind building this fence was to prevent the further return of
Rohingyas. On the other hand, Bangladesh enhanced the number of Rohingyas in sending back the Rohingyas to their country before Myanmar could build the fence (Perlez, 2014).

(Sen & Cynthia, 2012) stated that in April 2014, there had been 36,290 Rohingyas who asked for shelter in Malaysia. But Malaysia government sent them to immigration caps where they suffered from nutritious food, unhygienic sanitation and beating. The Rohingyas were not given work permit temporarily even though they had UNHCR certified document which caused them to work illegally. But it must be noticed that after so many harassments, the Rohingyas refused to return to their country as nothing left there for them and a fear that they would be again physically assaulted.

3.14 Vegetation change observation using Remote sensing

Adopting the well-known technology remote sensing using aerial or satellite images provides a significant historical records in examining spatial and temporal differences in land cover. By using satellite images, one can analyze different types of land cover changes which includes assessing deforestation, crop tress detection and in the field of environmental studies (Skole & Tucker, 1993). The amalgamation of remotely sensed and conducive data resources in remote sensing technology helps in monitoring and proper management of land resources at a multiple of scales. Integrating this technological support expands the new opportunities through displaying geographical data and give cost effective a analysis.

3.15 Application of remote sensing in environmental studies

Since 1993, there has been a plenty of agencies who are actively working in the field of environment relevance to the with refuges issues. In this regard a good example is Lutheran World Federation (LWF) who has developed guidelines for applying in emergency situations
(LWF, 2003). However, *Care International* which is generally United State based has financed for environmental assessment notably in the Great Lakes regions of Africa (ERM, 1994) & (ERM, 1995) which was actually considered as the blueprint in such kinds of situations for environmental analysis.

If we consider the revolutionary step of using “remote sensing” as a analytical tool in the global stage, it was evolved in 1993 by UNHCR through creating a post titled “senior coordinator on environmental affairs” where it was presented as environmental assessment and management tool following the environmental guidelines (UNHCR, 1996).

3.16 Application of remote sensing in assessing refugee shelters areas

The application of remote sensing in planning and management tool to analyze the refugee shelters and host places has increased in the recent time as it gives a cost effective output in environmental monitoring and assessment activities. Remote sensing is basically uses the aerial and satellite images to analyze moreover one associated tool called geographic information system (GIS) is also a powerful tool which academicians, practitioners and researchers are using in displaced affected areas since last two decades (Bjorgo, 2010). Remote sensing can be used to assess the physical characteristics of the earth surface as well as the human activity on their land. For example it can be land and vegetation cover, land use change, creating digital elevation model (DEM) and so on. The production of a new map after analyzing, it is not certainly fugitive and the total coverage of the areas which a sufficient work has been done to create a detailed map quickly is limited. None the less, remote sensing helps in acquiring and producing cheaply thematic maps for use in planning displaced people settlements. Such features are crucial in refugee shelters where agencies or researchers need speedy response (Bjorgo, 2010). There are few specific
applications of remote sensing which are specially useful in analyzing refugee situations. It includes producing thematic maps, identifying existing land use, locate roads and other settlements, noteworthy geomorphological features in order to establish new refugee settlements (Tachiiri & Ohta, 2004). The usage of satellite images for these types of works can provide with detailing very fruitful for researchers and academicians. In the recent time, satellite images are been used to produce land cover maps around the world refugee camps giving almost accurate estimations of the distribution specifically in large scale vegetation formations. However, in few cases, it may not be required to produce land cover maps by the refugee aid agencies since it is already been prepared by the host countries like Uganda, Tanzania and Afghanistan which give shelter to the significant number refugees or temporary displaced persons (Bjorgo, 2010).

Lot more tasks can be conducted through using satellite images although as with maps, it requires trained staff and ground truthing. For example, through the calculation of normalized difference vegetation index (NDVI) from the satellite images, it is possible to estimate the woody biomass of an area which can be used in examining the supplies of wood fuel and timbers (Tachiiri & Ohta, 2004). Researchers have also used the satellite images in estimating the total population size of

<table>
<thead>
<tr>
<th>Image</th>
<th>Spatial resolution</th>
<th>Temporal resolution</th>
<th>Spectral resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVHRR-NOAA</td>
<td>1 km</td>
<td>Daily</td>
<td>4 wavebands</td>
</tr>
<tr>
<td>Landsat-TM</td>
<td>30m</td>
<td>images/month</td>
<td>7 wavebands</td>
</tr>
</tbody>
</table>
Landsat 8  |  30m  |  Images /month  |  11 bands  
---|---|---|---
SPOT multispectral  |  20m  |  1 image/month  |  3 wavebands  
SPOT panchromatic  |  10m  |  1 image/month  |  1 waveband  
Radar images  |  Variable  |  Variable  |  Variable  
Air photographs  |  1:15000-1:50000  |  Irregular  |  Variable  

Table 1: Commonly used satellite images and their resolutions  
*Source:* (Lo, 1986)

a refugee camps. (Lo, 1986) introduced two methods for the estimation of population from aerial images. However, considering the African refugee camps, this method was applicable for below 10,000 population but for big towns or settlements it can be subject to inaccurate. What actually matters for satellite images is size of a pixel or an area from which a single spectral response is obtained. There is a disproportionate relation between pixel and spatial resolution. The larger the pixel is, spatial resolution will be lower moreover, less details will be obtained (Gandhi, Thummalu, Parthiban, & Christy, 2015). On the other hand, using higher spatial resolution images can be a bit expensive and time consuming as well for image processing analysis per unit area. (Gandhi, Thummalu, Parthiban, & Christy, 2015) in their studies said that commonly available aerial images ranges from AVHRR-NOAA, which basically serves daily images of the whole world however, maximum spatial resolution will be of only 1.1 km$^2$ from Landsat to SPOT imagery. High spatial resolution images are always in high demand by the researchers and practitioners as it provides images that can identify individuals and for this reason this images are widely produced
for the military officials. Availability of good quality maps is really significant to analyze however, topographic maps are mostly available at the 1:250000 scale (Alesheikh, Ghorbanali, & Nouri, 2007). One issue that should keep in mind that aerial photographs capturing from airplanes can provide much more detailing, but it will be expensive as well.

Nevertheless, satellite images have been widely used by UNHCR as well for analyzing the refugee areas notably host country Tanzania refugee camp, refugee camps of Northern Pakistan, South Sudan and most recently Rohingya refugee camps in Coxs Bazar, Bangladesh. One of the early applications of using satellite images in analyzing land cover changes was conducted by (Allan, 1993) in northern Pakistan refugees came from Afghanistan where the result showed the significant amount of deforestation and loss of green land in certain areas. (Allan, 1993) said in his research that using satellite images can give you details on features whereas, field verification can be costly and could take much time. So, in my research rather than going for field visit, I would prefer using satellite images. Same approach was adopted by (Leiterera, Bloeschb, Wulfa, Eugsterc, & Joerga, 2018) in their research which was on refugee camps hosted by South-Sudan. Their result showed about 50% decreased in forestation in the refugee camps and it’s surroundings areas.

On the other hand, unavailability of satellite images can be a problem in this regard, and this can happen due to cloudy images, unavailability of satellite coverage in that particular area. Such difficulty occurred in South-eastern Guinea where 5000,000 Liberian refugee were given shelter. (Black, 2014) stated that in that time the author did not find not even a single cloud free image available on SPOT or in Landsat satellites specifically for the period of 1988-95. The author also added that although few images were a bit cloud free found from January, that time a very little
cultivation took place and grasses converted into fields. They solved the situation by taking few aerial photographs though the quality was really poor.

The civil war occurred in early 1990 in Afghanistan which caused almost three million Afghans to flee to Pakistan in order to get shelter (Allan, 1993). Majority part of these refugee people got settled in the North-Western Frontier Province (NWFP). This province contains almost 75% of the total forests of Pakistan. They were been there for one decade which caused depletion of forest in a large scale of that region. (Lodhi, Echavarria, & Keithley, 2008) in their studies conducted on Afghan refugees sheltered in northern Pakistan refugee camps, applied remote sensing technology using satellite images. The authors used 1:50,000 scale for georeferencing and digital elevation model was created and conducted the change detection analysis by doing unsupervised classification. Moreover, elevation data was included in classification procedure in order to reduce the spectral confusion between agriculture and forest land cover classes. Eventually the comparison of two different date’s images showed dramatic decrease of forest lands.

3.17 Assessing Normalized Difference Vegetation Index (NDVI)

Generally, there are several indexes for highlighting vegetation based areas on remote sensing and Normalized Difference Vegetation Index (NDVI) is one of the mostly used indexes in the research field (Bhandari & Kumar, 2012). NDVI is an important index for analyzing vegetation of an area that is widely applied in environmental research and climate change. It is calculated as proportion difference between measured awning reflectance in the red and near infrared bands consequently (Jiang, et al., 2015). In their studies the authors tried to show the differences between the visible red and near infrared (NIR) bands of satellite images that can be applied to identifying the areas contain notable vegetation and other features.
Many Researchers and academicians have stated the utilization of NDVI in monitoring vegetation, assessing crop cover, drought analysis, agricultural fields and in global level (Mohammad & Bohloul, 2011). It also provides the growth trend result of crops which helps in long term decision making.

(Honeth, et al., 2017) proposed one of the procedures for environmental impact assessment for the refugee area located in Bangladesh. The authors suggested to conduct a classification to quantify the enormity of the impact for infrastructures, food security, social issues and most importantly land use departments. They expressed their concern for the energy demand which may cause severe loss to the forest areas and assumed that about 600 hectares may be vanquished per month. Except the proper monitoring and resource management the researchers expressed apprehension for drastic vulnerability to the host areas. The formula of conducting NDVI is as follows:

$$NDVI = \frac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}}$$

As different Landsat images denote different bands so NIR and Red bands can be different for different Landsat images. For example Landsat 7 consists of eight spectral bands with spatial resolution 30 meters for band 1 to 7 and band 8 (panchromatic) 15 meters whereas Landsat 8 consists of 11 spectral bands with spatial resolution 30 meters from band 1-7 and 9 and panchromatic band 15 meters and band 11, 12 is 100 meters (Peters, 2015).

(Hegazy & Kaloop, 2015) explained an approach for change detection in order to analyze the displaced people’s shelter area. The authors said to (1) use satellite images which would be free from cloud, (2) use Landsat satellite images as they provide comparatively good resolution image and used by National Aeronautics and Space Administration (NASA) moreover, to avoid field
verification due to limited budget or short time or security issues, (3) to adopt multi-scale approach to decrease the scale dependency of the produced change detection. This technique also discloses the wavelengths and spatial resolutions which are actually suitable to explain landscape changes at the local to regional scale.
4.1 Research Plan

Research methodology is a systematic and theoretical exploration of the selected methods that is applied to different fields of studies (Mary & Patrick, 2004). It must be stated that a methodology never provides solutions rather it shows the paths of conducting a research according to the area of interest. This chapter will discuss about the methods that were adopted to conduct the study. The preliminary steps of the research are stated below:

![Figure 2: Research Design of the study](image-url)
4.2 Design of the humanitarian operation

The history of Rohingya influx in Bangladesh and the reason behind persecution in Myanmar, this part will be analyzed by going through secondary data. According to the data almost one million Rohingya are currently being sheltered in Bangladesh in tow major refugee camps (Ukhia and Teknaf). It was definitely challenging for a developing country like Bangladesh to accommodate these large number of refugees however, UN organization came forward and running the humanitarian operation with the direct collaboration Bangladesh government. The following table will state the operation procedure occurring in the host area:
4.3 Satellite image downloading

To assess the land use change in remote sensing, it was essential to have satellite images and in this regard we downloaded the images from USGS earth explorer (https://earthexplorer.usgs.gov/) using Landsat 8. We selected to download images from Landsat 8 because so far it is the latest satellite in Landsat program. The quality of the data (single to noise ratio) and radiometric quantization (12 bits) of the selected Landsat’s Operational Land...
Imager (OLI) and thermal Infrared Sensor (TIRS) are far better than previous Landsat satellites (8 bit for TM and ETM+) (Peters, 2015). Landsat 8 was launched on 11th February 2013 and from then it has providing high resolution images for us which are containing very useful information that are being used for research purposes. Generally, Landsat 8 images have 11 bands with different wavelengths and resolution.

<table>
<thead>
<tr>
<th>Band</th>
<th>Wavelength (micrometers)</th>
<th>Resolution (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band 1 – Coastal Aerosol</td>
<td>0.43 – 0.45</td>
<td>30</td>
</tr>
<tr>
<td>Band 2 – Blue</td>
<td>0.45 – 0.51</td>
<td>30</td>
</tr>
<tr>
<td>Band 3 – Green</td>
<td>0.53 – 0.59</td>
<td>30</td>
</tr>
<tr>
<td>Band 4 – Red</td>
<td>0.64 – 0.67</td>
<td>30</td>
</tr>
<tr>
<td>Band 5 – Near Infrared (NIR)</td>
<td>0.85 – 0.88</td>
<td>30</td>
</tr>
<tr>
<td>Band 6 – SWIR 1</td>
<td>1.57 – 1.65</td>
<td>30</td>
</tr>
<tr>
<td>Band 7 – SWIR 2</td>
<td>2.11 – 2.29</td>
<td>30</td>
</tr>
<tr>
<td>Band 8 – Panchromatic</td>
<td>0.50 – 0.68</td>
<td>15</td>
</tr>
<tr>
<td>Band 9 – Cirrus</td>
<td>1.36 – 1.38</td>
<td>30</td>
</tr>
<tr>
<td>Band 10 – Thermal Infrared (TIRS) 1</td>
<td>10.60 – 11.29</td>
<td>100</td>
</tr>
<tr>
<td>Band 11 – Thermal Infrared (TIRS) 2</td>
<td>11.50 – 11.51</td>
<td>100</td>
</tr>
</tbody>
</table>

**Table 2: Landsat 8 Bands information**  
Source: (Peters, 2015)

Our study area is two major refugee camps called Kutupalang refugee camp and Nayapara refugee camp from Ukhia and Teknaf upazila. In order to get the images from this sites, we downloaded images from Landsat 8 on different dates. We took images from three different years in 2016, 2018 and 2020. As the Rohingyas came on August 2017 so before their entrance image of 2016, after their presence in 2018 and most recent image from 2020. We will try to see what the scenario in the host place before their entry was, next what happened within next eight months after they were given shelter in the refugee area and 2020 image will illustrate
what is the present scenario. In this study we avoided the night time images as day time images give more high resolution and bright images.

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Image</th>
<th>Image acquisition date</th>
<th>Cloud coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landsat 8</td>
<td>Image 1</td>
<td>May 8, 2016</td>
<td>Less than 10%</td>
</tr>
<tr>
<td>Landsat 8</td>
<td>Image 2</td>
<td>April 28, 2018</td>
<td>Less than 10%</td>
</tr>
<tr>
<td>Landsat 8</td>
<td>Image 3</td>
<td>May 19, 2020</td>
<td>Less than 10%</td>
</tr>
</tbody>
</table>

Table 3: Acquired images details for the study area

4.4 Image processing through supervised classification

Since the study aims to see the land use pattern of the refugee area, we decided to conduct the supervised classification. Supervised classification gives the land use pattern of an area and doing the same analysis in the same area will provide the land use change in different years. Once the images were downloaded, the images were extracted and taken in the erdas imagine software. Since Landsat 8 images have 11 bands so it was needed to merge them and make one single image. However, in this regard we took only four bands to do the mosaic (merge). Band 2, band 3, band 4 and band 5 were used to do the mosaic. Band 2, band 3 and band 4 reflects the blue (wavelength .45-.51 micro meter, green (wavelength .53-.59 micro meter) and red color (wavelength .64-.67 micro meter) of the earth surface and band 5 reflects the near infrared (NIR) which wavelength is (.85-.88 micro meter). Resolution of these four bands are 30 meters. We also did the principal component analysis (PCA) to remove all the unnecessary data from the
selected bands. In this following step two PCA bands are produced. PCA band 1 helps to identify
the water body in the image. In order to take the AOI data, we went through the previous studies
and google earth images that we can assume how many land classes exist in the study area. For
the years 2016, 2018 and 2020 we selected three classes as forest land, camp forest and camp
settlement. These three classes are denoted as green, yellow and red color sequentially. After
taking the AOI data, supervised classification was run and final land classification image we
acquired. This whole supervised classification process is conducted individually for three different
years.

Supervised classification is conducted through selecting sample pixels in an image that represent
specific classes (e.g. water body, forest land) and the process the images using remote sensing
or Arc GIS software to use the training data as references in order to classify all other pixels in
the image (Lu & Weng, 2007). In this study we will designate the number of classes that the
images are classified into. Usually the researchers adopt both supervised and unsupervised
classification procedure to develop a final output of classified maps however, we will use only
supervised classification method for this study.

4.5 Area calculation

After being supervised classification was conducted, we calculated the area of the selected
classes. This step is very crucial as it provides the area size of our study area for the particular
classes (camp forest, camp settlement and forest land). Through doing this we can know the what
was the size for our selected three classes in 2016, 2018 and 2020. We measured our unit in
“square meter”. The result would show that in a year particular class increased or decreased.
Area of each class is calculated by multiplying the total pixel count to pixel resolution.
4.6 Normalized Difference Vegetation Index (NDVI) processing

Doing NDVI of the study area will illustrate the vegetation level of the selected area. This analysis tells the good to poor vegetation with the value -1 to +1. If the value is +1 to positive values, it denotes the good vegetation and values near negative denotes the poor vegetation. To conduct the NDVI, we merge the band 2, band 3, band 4 and band 5 images to make it a single image. These four bands reflect the blue, green, red and NIR sequentially. Then NDVI is calculated using the formula:

\[
NDVI = \frac{NIR - Red}{NIR + Red}
\]

For Landsat 8, the formula will be: \(NDVI= \frac{\text{Band 5}-\text{Band 4}}{\text{Band 5}+\text{Band 4}}\)

Here, Band 5= Near Infrared (NIR) and Band 4= Red
Chapter 5: Research Findings and Discussion

This research findings chapter will illustrate the results after analyzing the data and discuss the output. It is expected to implement the procedures that are discussed in the previous research methodology chapter.

5.1 Population distribution

According to the data of 2018 there are total 905,800 Rohingyas are living in the refugee camps of Bangladesh. There are in total 34 camps however, major two camps are Kutupalang refugee camp and Nayapara refugee camp. Among them 471,016 are men and 434,784 are women. Analysis says that 52% are women and 48% are men in the refugee camps.

5.2 Refugee number according to age

Among the total number of population there are different ages of Rohingya are living in Bangladesh. We have classified ages into five categories, and these are ages (0-4) years who are children, ages 5-11 years, ages 12-17 years, ages between 18-59 years who are denoted as adults and >59 years who are elderly people. Analysis says that majority 41% of Rohingyas are between 18-59 years where the total number is 371,000. Children whose age is 0-4 years are 163,000 which is 18%, 5-11 years are 208,000 (23%), 12-27 years are 127,000 (14%) and elderly people are only 36,300 which is 4% of total population.
5.3 Land use pattern of 2016

The land use map of 2016 states very clearly that in that time the study area was mostly surrounded by the forest land as refugees did not come by that time. The red zone (camp settlements) was in a very little amount. The camp forest (yellow part) denotes to those lands which are near of the settlements and due to that forests or green land are becoming pale.
5.3.1 Area calculation for the year 2016

The following table is illustrating that in 2016 camp forest was 6092.90 sqm, forest land was 25938.02 sqm and camp settlement was only 3940.85 sqm.

<table>
<thead>
<tr>
<th>Legend</th>
<th>Pixel count</th>
<th>Area (sqm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camp forest</td>
<td>6769894</td>
<td>6092.9046</td>
</tr>
<tr>
<td>Forest land</td>
<td>28820024</td>
<td>25938.0216</td>
</tr>
<tr>
<td>Camp settlement</td>
<td>4378725</td>
<td>3940.8525</td>
</tr>
</tbody>
</table>

Table 4: Area Calculation of the study area for 2016
5.4 Land use pattern of 2018

From this land use map for the year 2018 of the study area it can be clearly stated that there became a drastic change in total land use. Specially the size of the forest land decreased in a rapid way since refugee started living there. Moreover, to build their houses and cooking fuel purpose the refugees cut the trees and forest as a consequences it took dramatic change. Following area calculation table would give more accurate scenario of the area for the year 2018.
5.4.1 Area Calculation of 2018

This table illustrates that in 2018 forest land was 14328.66 sqm, camp settlement was 10589.688 sqm and camp side forest was 11829.6 sqm.

<table>
<thead>
<tr>
<th>Legend</th>
<th>Pixel Count</th>
<th>Area (sqm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest land</td>
<td>15920736</td>
<td>14328.6624</td>
</tr>
<tr>
<td>Camp settlement</td>
<td>11766320</td>
<td>10589.688</td>
</tr>
<tr>
<td>Camp forest</td>
<td>13144000</td>
<td>11829.6</td>
</tr>
</tbody>
</table>

Table 5: Area Calculation of the study area for 2018

5.5 Land Use pattern of 2020

Land use of map 2020 would give us the current scenario of the study area. It has been almost 2.5 years since Rohingyas are here in Bangladesh. By this time humanitarian operation has become more environmentally friendly and sustainable. As a result, we can see that comparing to 2018, scenario has bit changed. Specially forest land and camp forest has developed though in a very little amount.
5.5.1 Area Calculation for the year 2020

In 2020, forest land is 14449.11 sqm, camp settlement is 12721.44 sqm and forest side land size is 9119.64 sqm. Data says that from 2018, environment has developed a little bit considering forest land size.
5.6 Area comparison for the year 2016, 2018 and 2020

Comparing the area calculation data for the selected years we can see the difference in the land size. In 2016, the forest land was 25938.02 square meters however in 2018 it became 14328.66 sqm. Here 11609.36 sqm land was deforested. But in 2020, the land area came 1449.11 sqm. It very specifically indicates that 120.34 sqm land has converted to forest land.

Differentiating the camp side forest data between 2016 and 2018, we can say that camp forest has increased by 5736.7 sqm however from 2018 to 2020 it has developed and decreased the size by 2709.96 sqm. Coming to the settlement data, from 2016 to 2018 the land was occupied by 6648.83 sqm which was completely given shelter to the Rohingya refugees. But in comparison between 2018 and 2020 the data says coming in 2020 camp size has been increased by 2131.76 sqm.

<table>
<thead>
<tr>
<th>Year</th>
<th>Forest land (sqm)</th>
<th>Change (sqm)</th>
<th>Camp forest (sqm)</th>
<th>Change (sqm)</th>
<th>Camp settlement (sqm)</th>
<th>Change (sqm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>25938.02</td>
<td>6092.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Area Calculation of the study area for 2020

<table>
<thead>
<tr>
<th>Legend</th>
<th>Pixel count</th>
<th>Area (sqm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camp settlement</td>
<td>14134942</td>
<td>12721.4478</td>
</tr>
<tr>
<td>Forest land</td>
<td>16054576</td>
<td>14449.1184</td>
</tr>
<tr>
<td>Camp forest</td>
<td>10132937</td>
<td>9119.6433</td>
</tr>
</tbody>
</table>

Legend
- Pixel count
- Area (sqm)
Table 7: Change in selected classes

<table>
<thead>
<tr>
<th>Year</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
<th>Class 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>14328.66</td>
<td>11609.36</td>
<td>11829.6</td>
<td>5736.7</td>
<td>10589.68</td>
</tr>
<tr>
<td>2020</td>
<td>14449.11</td>
<td>120.45</td>
<td>9119.64</td>
<td>2709.96</td>
<td>12721.44</td>
</tr>
</tbody>
</table>

5.7 Difference in NDVI map between 2016 and 2018

NDVI indicates the level of vegetation in an area. Generally, its value exists from +1 to -1. In the following NDVI maps for the years 2016 and 2018 we can clearly visualize the difference in vegetation. As much as the color is green it is good quality vegetation and towards red color indicates the poor-quality vegetation. For the maps we took five classes green to red. Where in 2016 the green portion was from +.999 to +.263 covering four classes out of five classes. However, in 2018 the portion of red color increased which says that in this year vegetation level deteriorated.

**Figure 8: Difference in NDVI maps of 2016 and 2018**
5.8 Difference in NDVI map of 2018 and 2020

As we conducted NDVI analysis on three different years so in this section we will compare the NDVI maps between 2018 and 2020. From the following maps we can say that in 2020 the vegetation level started developing a bit though amount is very low. In the map of 2020, it is observed the abundance of red portion however a bit better than 2018 map. One common thing is that lacking of highest level green vegetation in the study area for the following two years.

Figure 9: Difference in NDVI maps of 2018 and 2020
Chapter 6: Conclusion

It can be said that Rohingya community have become one of the largest refugee groups in the world and they are forcibly being sheltered in their neighboring country Bangladesh with more than one million. The reason behind fleeing to Bangladesh is more political and internal clashes. As a consequence they are living in Bangladesh as stateless group and their presence has created a huge negative impact on the environment. In order to assess the land use change and measure the vegetation level, remote sensing technique is used and all over the world. Producing land use map for different three years (2016, 2018 and 2020) have shown the change in the refugee driven area. Previous studies on different refugee camps prove the efficiency of using remote sensing for this study. Moreover, the approach which is adopted to observe the land use change is conducting supervised classification and analyzing NDVI. Supervised classification provides the land pattern difference through classifying the area into different classes. This study followed exactly the same approach and the output of this result is easy to interpret for the readers though he/she is from the different field. That’s why adopting this technique is seems very suitable to conduct this research. The study finds that in 2016 the study area (Kutupalang refugee camp and Nayapara refugee camp) was mostly surrounded by forest land however, after August 2017 when Rohingya people entered in Bangladesh, it took a drastic change. The forest land converted into camp settlements and people used forest wood as coking fuel. This research will help further studies for the new researchers as it clearly states that Landsat 8 images, supervised classification and NDVI analytical tool can provide actual idea about a area. But this study could be improved by going to the field visit or face to face interaction since these issues give more detail information. Besides while choosing satellite images one should more careful about taking cloud
free images and check the footprint of the image. But it is matter of positive hope that as UNHCR along with other aid agencies have introduced Liquefied Petroleum Gas (LPG) and distributing among the refugees, forest land has started rebuilding again and land use map of 2020 is saying exactly the same and secondary data and government policies also clarify this statement. Scenario is developing considering the green lands. NDVI maps also illustrate the same and show the deterioration occurred in 2018 however healthy vegetation was in 2016. Though it’s not covered in this study, but secondary data and other valid news say that Bangladesh government is trying to relocate the refugees in a new camp in Vashanchar, Hatia upazila of Bangladesh which would make the environment more sustainable. Keeping the political and internal problems in Myanmar, both governments should sit together and come to an agreement how this large number of Rohingya refugees can be sent back to their normal life. In the last we can state that in monitoring a land and to visualize the change remote sensing can be a very helpful component for the researchers and policy makers and help in further decision making.
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