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LAND USE AND LAND COVER CHANGE AND ITS EFFECT ON LAND SURFACE TEMPERATURE: AN IMPACT ANALYSIS OF ROHINGYA INFLUX IN UKHIA UPAZILA BETWEEN YEAR 2000 TO 2020

Touhidul Islam[*], Md. Muaz Hussain[*1], Md. Saneul Alam Shiam[*], Minhazul Abedin[*], Md. Erfanul Hoque[*]

[*]*Chittagong University of Engineering and Technology*

[1]***Corresponding Author**:*
smmuazhusain@gmail.com

Abstract:

Bangladesh is a country of near about 16 crore people with recently earning status of middle-income economy. The country is already facing so many challenges in the economy and increasing population growth. Overcrowding is one of the main concerns of the country right now. Social Crimes, unsafety etc. are the day-to-day deals of the people of our country. Though all these problems are present, the country is growing in the case of its economy. But a country like ours which is already encountering so many problems, is facing another big challenge of refugee issues. In 2017, 655,000 Rohingya refugee came to Bangladesh in search of safety from the Myanmar militaries and built their residences at the coastal upazilas of Bangladesh. This led to a tremendous amount of tree cutting, landfilling and other damage to nature. The Ukhia Upazila is the place for the largest refugee camp of the Rohingya people. To make this camp huge areas have faced deforestation to meet the needs of the helpless people. Every element of nature has been damaged. By Conducting Land Use and Land Change Detection methods, the study has tried to show the amount of damage done by these deforestations and their impacts on the environmental parameter. From the years 2000 to 2020, a total of 36.39 sq. km. of vegetation area has been damaged. 25% of the bare lands have been converted to other land uses for fulfilling the purposes of people living there. 2.88% of waterbodies have been decreased from the year 2010 to 2020. Dense vegetation has decreased from 118.77 sq. km. to 82.3 sq. km. The land use change rate has also increased from 3.6% to 5.4% in over a year gap. The average land surface temperature increased to 26.5 degrees Celsius as a result of the continuous elimination of land covers. Further analysis of the thesis paper will give details information on the Land use landscape change and its impact on the environment.

INTRODUCTION:

Bangladesh is a land of natural resources. Nearly 700 rivers, A mangrove forest, and Hilly tracts along the northeastern and the southeastern part of the country make the geography so beautiful and challenging to live in at the same time. Despite being a country with a middle-income economy, there are several issues across the country that the people are facing now. Chittagong, which is situated in the South-eastern part of the country is considered the economic capital of Bangladesh. The demographic status of the Chittagong district is so versatile. Despite having an overwhelming Bengali Muslim majority, Chittagong has a high level of religious and ethnic diversity among Bangladeshi cities. Bengali Hindus, Bengali Christians, Bengali Buddhists, Chakmas, Marmas, and Bohmong are among the minorities. Chittagong is an important part of Bangladesh's economy. Chittagong is an ancient seaport because of its natural harbour. The largest sea beach in the world is situated in Cox's Bazar district of Chittagong. Besides the longest sea beach in the world, it is also blessed with many tourist places. The Cox's Bazar district holds geographic importance too because of is close to the Bangladesh-Myanmar border. The local people of Cox's Bazar district are also familiar with the fact that Rohingya Refugees taking shelter in the district since the early 90s. Since August 25, 2017, Rohingya refugees have fled to Bangladesh as a result of a targeted campaign of violence by Myanmar's military, police, and local militias.(Imran et al., 2017). As of 11 December 2017, approximately 655,000 refugees had settled in Bangladesh. Within a few months, the Kutupalong refugee camp had grown dramatically, and the vegetation in the surrounding forests had decreased (Braun et al., 2016)**.** A refugee is generally a person who is outside their country of nationality or habitual residence and cannot return safely owing to serious and indiscriminate threats to life resulting from generalized violent events like war, forceful expulsion, genocide, etc**.** (UNHCR, 2011)**.** Before the most recent influx of 2017, several inflows had occurred previously and more than a quarter million of them had already lived in Bangladesh for decades (HRW, 2017)**.** The effect of the refugee crisis on the host country's climate and natural resources has emerged as a new concern. It contributes to environmental degradation, such as deforestation and firewood destruction, land degradation, unstable groundwater extraction, and water contamination. In the case of Bangladesh, a few studies were recently conducted to assess environmental degradation (on vegetation) in Cox's Bazar as a result of refugee accommodation. Human behaviour and interactions with the environment cause environmental change. The environment is facing a critical problem due to several factors such as increasing population, environmental exploitation, deforestation, improper land use, and anthropogenic activities (Benzer, 2010)**.** Vegetation on the southern coast of Bangladesh plays a vital role in the climate change adaptation and mitigation process in the region. The tradition of cutting trees for firewood in refugee camps has resulted in substantial deforestation. Following the influx of refugees, there has been a significant loss of vegetation cover. Forestland is being razed to make room for this massive influx of migrants, posing a serious threat to wildlife habitats, biodiversity, and whole ecosystems in the area.(Rahman et al., 2019)**.** In January 2017, the Bangladeshi Government announced plans to relocate the 32,000 registered Rohingya refugees who have spent years in camps near the Myanmar border (the 200,000 unregistered other refugees were not officially part of the government's relocation plan. Initially, Bhasan Char, an island 18 miles east of Hatiya Island was reportedly selected for the relocation. A subsequent report put the location as 200 hectares selected on Hatiya Island, a nine-hour, land-and-sea journey from the camps (Rahman et al., 2019)**.** The Rapid Environmental Assessment Study was initiated by the Ministry of Environment and Forest (MoEF) of Bangladesh and by UNDP and UN Women to assess the environmental impacts of the Rohingya influx into Bangladesh and propose a series of actions to address the high environmental risks related to the influx. The UNHCR Environmental Guidelines (1996) state that the environmental impacts of an influx of asylum seekers in host countries include: "uncontrolled fuelwood collection, poaching, and overuse of limited water supplies (UNHCR & IUCN, 2018)**.** These impacts have placed serious strains on the ecosystems in many regions, including some unique areas set aside by local governments as parks or reserves or even sites recognized by UNESCO as World Heritage Sites (Rahman et al., 2019)**.** In the worst case, these activities, if continued, could result in irreversible losses of productivity, the extinction of species of plants or animals, the destruction of unique ecosystems, the depletion or long-term pollution of groundwater supplies, or a variety of other destructive outcomes (Gandhi et al., 2015)**.** Overuse of natural resources such as the unregulated collection of firewood and the extraction of groundwater may give rise to conflicts between the Rohingya and the host communities, which could disproportionally affect women as one of the most vulnerable groups of the population.

Objectives

- To detect Land Use and Land Cover change of Ukhia Upazila by using multi-temporal remote sensing techniques during the period 2000-2020 (2000, 2010 and 2020).
- To detect comparative Land use change speed between the years 2000-2010 and 2010-2020.
- To stimulate the Spatial land surface temperature (LST) of years 2000,2010, and 2020 and its relation with land use and land cover change.

Literature Review:

Refugees coming from Myanmar are called Rohingyas who are an ethnic group of people and considered as a minority community living in North Arakan in Myanmar. This minority community is not regarded as a citizen of Myanmar despite their residence in Myanmar for centuries. Rohingyas have no freedom of movement and need to apply for passes (even for travelling purposes in their country of domicile) which are not free of charge, limited marketing access and limited

employment opportunities (Kok, 1989). Bangladesh has been experiencing the problems of the issues of Refugees since 1978; almost 200,000 refugees came into Bangladesh and took shelter. These refugees fled from Myanmar and are known as "Rohingya". Again in 1991-92, approximately 250,000 refugees fled from Myanmar's western Rakhine state and this ethnic, linguistic and religious minority of the Myanmar community started living in the southeast district of Cox's Bazaar (Imran et al., 2017). Rohingya refugees again started arriving in Bangladesh in August 2017, fleeing atrocities deemed serious crimes under international law by United Nations investigators Over 740,000 new refugees have settled in two camps in Cox's Bazar district of Chittagong: Kutupalong-Bulukhali and Nayapara-Leda. The number of Rohingya in Cox's Bazar now stands at around one million, comprising about 30 per cent of the population. Kutupalong-Bulukhali is now the largest refugee camp in the world (Khana et al., 2009).

Key Chronological Events of Rohingya Refugees in Bangladesh

Time of Event	Details
1978	Approximately 200,000 Rohingya Muslims fled due to the Burmese army's Operation and About 10,000 refugees remain in Bangladesh, 10,000 die in the camps, and 180,000 are forcibly repatriated.
1991- 1992	The influx of approximately 250,000 Rohingya Muslims due to forced labour, land confiscation, religious intolerance, rape, and other forms of persecution by the Myanmar military regime.
1993-1997	230,000 Rohingya repatriation to Myanmar.
2017	The latest influx started at 655,000 arrived from 25th August to 26th December.
2018	904,373 total refugees, 836404 new arrivals since 8th August 2017.
2019	914,998 total refugees and 744,400 new arrivals since 8th August 2017.
2020	861,545 total refugees, 826,485 registered under GoB-UNHCR

Source: (Holland et al., 2002; Ullah et al., 2021)

Environmental Impacts of Rohingya refugees: The Rohingya gather whatever materials they can to build their shelters and this has resulted in massive cleaning of the vegetation cover from hills and forests. Fuelwood for daily cooking is also being collected from forests, and this is causing serious forest degradation and habitat destruction (Arfin Khan et al., 2012). A new access road to the Rohingya camps on the Cox's Bazar – Teknaf highway is under construction and this will facilitate access not only to the camps but also to the forests and their resources (Ministry of Environment and Forests, 2018). Primary shelter materials in the camp area are tarpaulin, aluminium and bamboo which are non-disposable items except bamboo. Drinking water was supplied to the Rohingya camps through plastic containers which is another non-disposable item which is harmful to the environment (Choudury & Fazlulkader, 2019). Smoke and dust generated from stoves and traffic is a source of air pollution., A lack of solid waste management in the Rohingya camps is causing water pollution in nearby streams; unmanaged human waste is being channelled to hilly streams and contaminating water (Ministry of Environment and Forests, 2018).

Socio-Economic Impacts: An interview in Rohingya refugee camps in Bangladesh reveals about 500 Rohingya prostitutes are living in Kutupalong and many of them are living there for long days and persuading other women and girls who have recently been affected in Myanmar and take shelter in refugee camps of cox's Bazar (E. Haque, 2018). Unemployment and scarce work opportunities for Rohingyas keep them under vulnerability to being victims of any persuasion or offer of a better life and in turn entangling them with trafficking (E. Haque, 2018). Crime syndicates involved in Rohingya trafficking to smuggling Rohingyas who are reluctant to stay in the camps. 43.75 per cent of local people fear that the Rohingyas might be allured into drug smuggling (Choudury & Fazlulkader, 2019). Numerous examples indicate drugs are highly affecting the host community. Most people are seriously worried about it and it is going to be a threat to society. All the local respondents acknowledge that drugs, especially Yaba have been spread all over the area. Even they have expressed resentment that this area has become the hub of drug business for the entire country and the sheer amount of supplies are covered through this area (Idrish, M.H. & Khatun, 2018). Almost 5,00,000 Rohingya people were living in Bangladesh before the influx in August 2017. More than sixty per cent of local people ensured that they know many Rohingya who have bought land in Bangladesh. The places where Rohingya people have bought land are mostly in Cox's Bazar City, Ramu, Chakaria, Pekua, Satkania, Chandanaish, Raozan etc. (Idrish, M.H. & Khatun, 2018). The language spoken by the Rohingyas and the local people of Cox's Bazar is almost similar which allows the Rohingyas to assimilate quickly with the local peoples. The daily wage earners also switch to work with the aid agencies to work in the camps since the jobs are readily available. This creates problems for the farmers since it has now become difficult for them to find labourers to work their farms (Khatun, 2017).

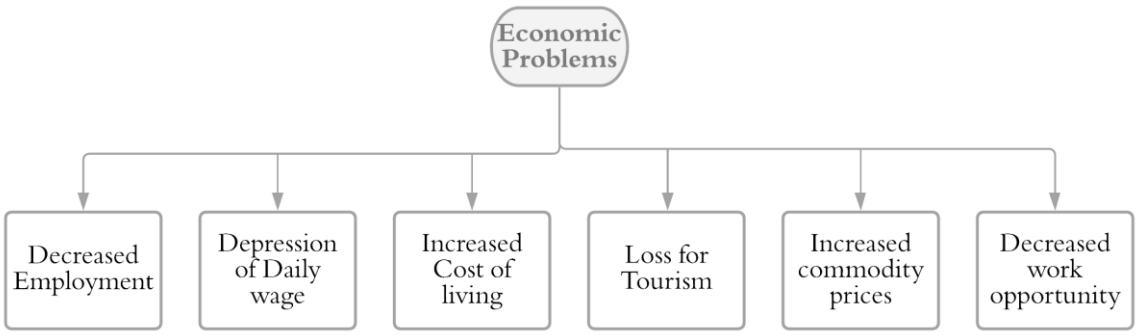

Figure: Major Economic Problems of Ukhia

The nominal gross domestic product of Bangladesh in 2016 was 221.4 billion USD in current USD (The World Bank, 2018)**.** According to the Bangladesh Ministry of Finance, the Government revenue in 2017 was 28.64 billion USD in the present day's currency and present exchange rate. Conservative estimates place the required aid to provide for the Rohingya refugees at 1 billion USD a year (Ovi, 2017), which amounts to about 3.5 % of the Government's revenue in 2017. A more recent article however, says that Bangladesh was paying 280 million USD to relocate about 100.000 Rohingya refugees to the island of Bhasan Char, as a longer-term solution (Spicer, 2018)**.** From research, It was seen that almost 74 per cent of respondents strongly agreed with the statement that Because of the Rohingyas influx local environment and Economy were enormously damaged (Choudury & Fazlulkader, 2019)**.** The sudden influx of mainly low-skilled workforce with the ability to substitute the local workforce would put negative pressure on the wages of the local labour market. The Rohingyas share a religious identity with the people of Bangladesh. Their language is different from Bengali however, it is very similar to the Chittagonian dialect, hence Rohingya refugees can understand and speak the language of the Chittagong area. Since the regions of Ukhia and Teknaf are considered the poorest in Bangladesh, half of their population lives in unskilled labour jobs, which means that the outnumbered locals have to face significant competition (Clare Baldwin & Andrew R.C. Marshall, 2018)**.** The critical migration theory, suggests, that migration is a way to move cheap labour. In this sense, the forced migration of Rohingyas resulted in the accumulation of cheap labour (Laszlo, 2018)**.** The influx of refugees logically means an increased labour supply, which causes a decrease in wages for low-skilled jobs. However, local skilled labour can enjoy benefits from the increased international presence a refugee

crisis entails. Furthermore, in case refugees arrive in an area, where there is a gap in the labour supply, they can take part in the local labour market without any negative impact on wages (Sood & Seferis, 2014).

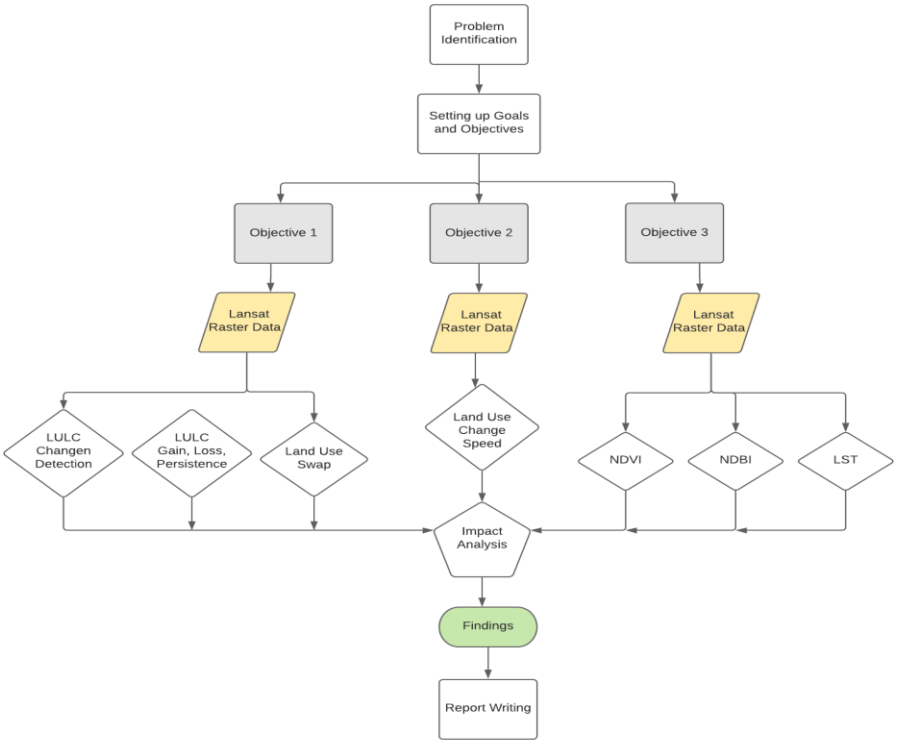

Figure: Flow Chart of Methodology

Methodology:

Study Area Profile: The study area of the research work has been selected as the Ukhia Upazila. It includes five unions named Haldia Palong, Jalia Palong, Raja Palong, Ratna Palong and lastly, Palong Khali Union. Ukhia Upazila occupies a total of 261.8 sq. Km. area, the area occupied by reserved forest is 155.14 sq. Km. and the total riverine area is 0.91 sq. Km. Total population by the year 2011 was 207379 out of which male 104567 and female 102812, Muslim 189821, Hindu 4340, Buddhist 13000, Christian 31 and others 187 (Bangladesh Bureau of Statistics (BBS), 2011)**.** Indigenous community such as Chakma, belongs to this upazila. The main water bodies are portions of the Naf River and Reju Canal, Inani Canal, Madhuchara Canal etc. The main tourist place of the upazila is Inani Seabeach (Bangladesh Bureau of Statistics (BBS), 2011; Towhid Hossain Chowdhury, 2016)**.** Ukhia Upazila is located between 21°05' and 21°21' north latitudes and 92°03' and 92°12' east longitudes. It is situated at the Cox's Bazar zila of Bangladesh. Cox's Bazar upazila is in the most southern part of the country and a coastal district. Among the eight upazila, Ukhia is one of them. Ukhia upazila is surrounded by different land topologies, somewhere it is flat lands and somewhere there are hilly lands with forest covers. The total area of the upazila is 258.3 Sq. km. (Bangladesh Bureau of Statistics (BBS), 2011)**.** In the eastern direction of Ukhia upazila, there is the Arakan state of Myanmar and Naikhongchhari upazila. The Bay of Bengal is on the western side of Ukhia upazila. The north side of Ukhia is neighbored by Ramu upazila. Teknaf Upazila is situated on the southern side of Ukhia Upazila

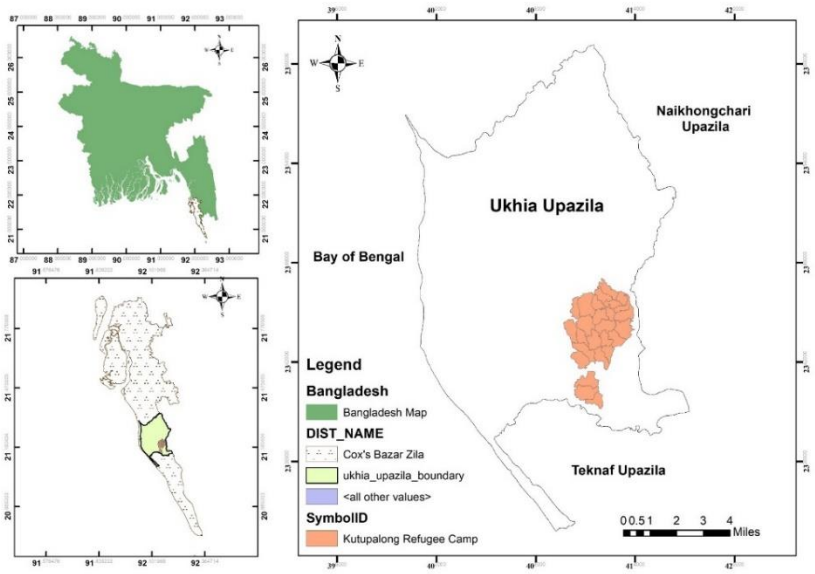

Figure: Location Map

Analysis and Discussion:

Table: Accuracy assessment of supervised classification

Land Use Categories	2000		2010		2020	
	UA	PA	UA	PA	UA	PA
Bare land	75	85	81	66	81	88
Refugee Camp			88	100	82.5	87
Settlements	83	86	87	78	84	90
Water bodies	82	87	80	88	83	100
Vegetation	85	94	80	94	83	
Overall Accuracy	81		83.2		82.7	
Kappa coefficient (%)	81		84		85	

Land Use and Land Cover Maps of Different Categories

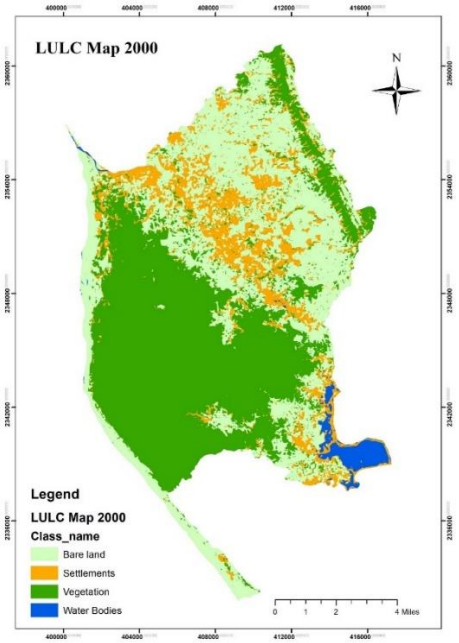

Figure: LULC map year 2000

The land use and land cover map of the year 2000 shows that there were no refugee camps in that year. The land use categories were of four types. Bare land included agricultural land along with sandy lands and open spaces.

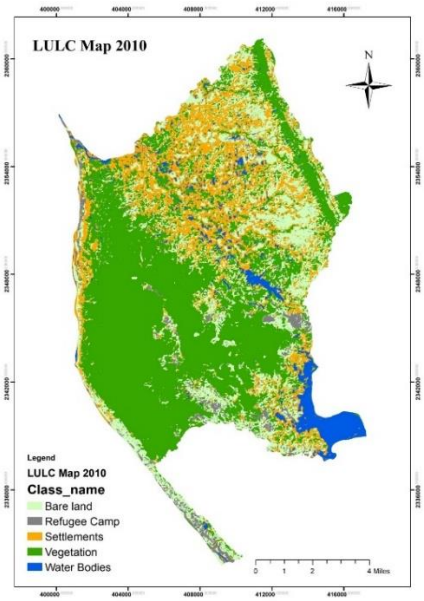

Figure: LULC Map of the year 2010

The land use and land cover map for the year 2010 shows that there were a few spaces required for the refugee camps in that year. The land use categories were of five types. Bare land included agricultural land along with sandy lands and open spaces. Vegetation cover refers to both forest lands and sparse or light vegetation covers like shrubs and herbs inside the upazila.

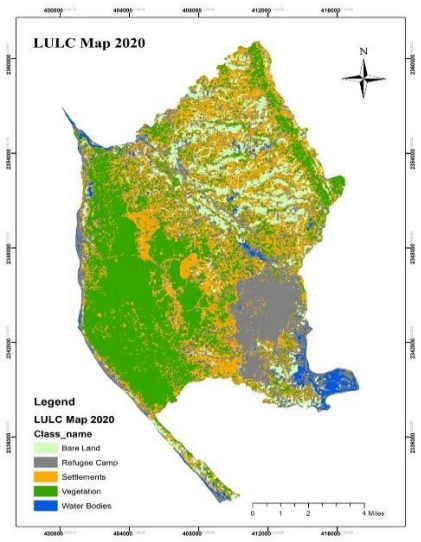

Figure: LULC Map of the year 2010

The LULC map for the year 2020 defines there was a large area of space occupied by the refugee camps in that year. The land use categories were of five types. Bare land included agricultural land along with sandy lands and open spaces. Vegetation cover refers to both forest lands and sparse or light vegetation covers like shrubs and herbs inside the upazila boundary.

Land Use Cover and Percentage (%) of Different Categories

Table: LULC area quantity & percentage

Categories	Year 2000		Year 2010		Year 2020	
	Area (km^2)	Percentage (%)	Area (km^2)	Percentage (%)	Area (km^2)	Percentage (%)
Bare land	97.32	37.68	57.79	22.37	31.78	12.3
Refugee Camp	0	0	11.82	4.58	59.72	23.12
Settlements	35.64	13.8	49.01	18.97	70.95	27.47
Vegetation	116.81	45.22	126.91	49.13	90.52	35.05
Water Bodies	8.53	3.3	12.76	4.94	5.32	2.06

Total	258.3	100	258.29	100	258.29	100

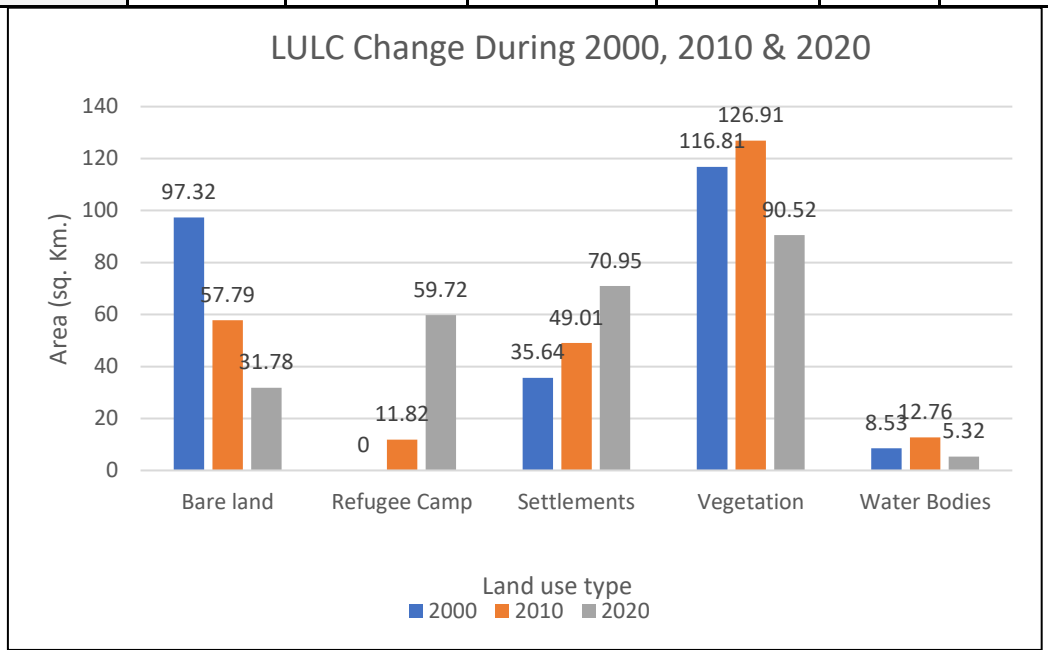

Figure: LULC Change During 2000, 2010 & 2020

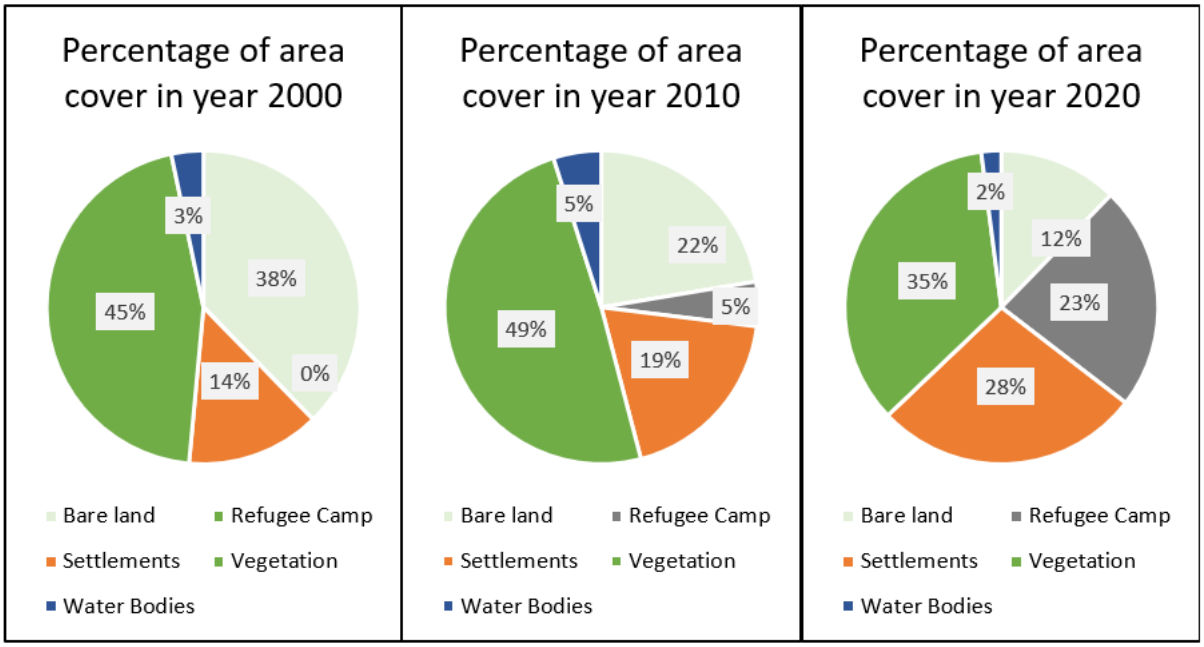

Figure: Percentage of area cover in 2000, 2010, 2020

Relative changes in the quantity of LULC categories

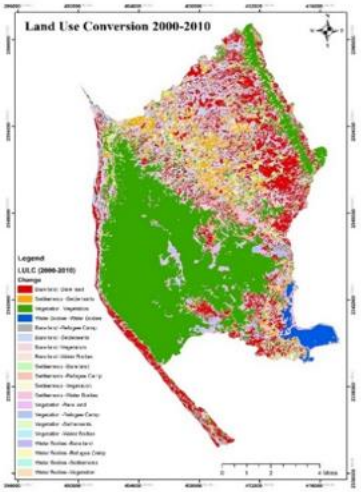

Figure: Land use conversion 2000-2010

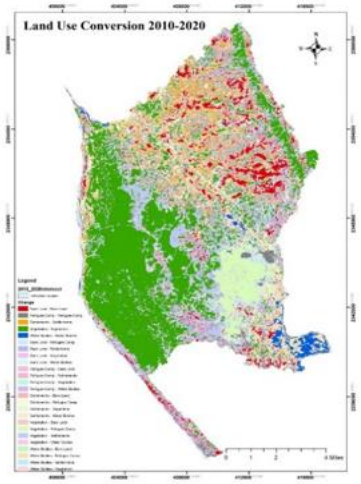

Figure: LULC conversion 2010-2020

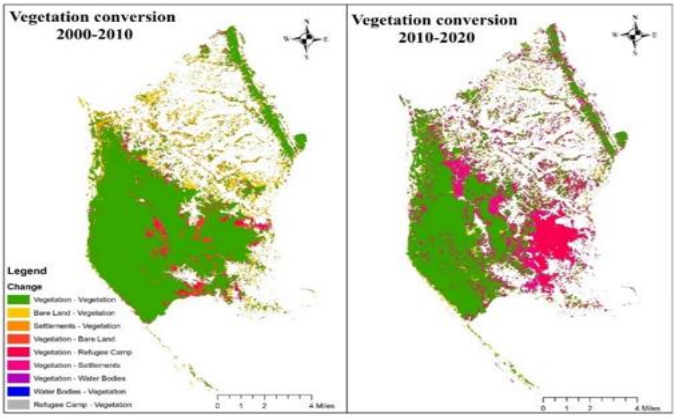

Figure: Vegetation Conversion Map

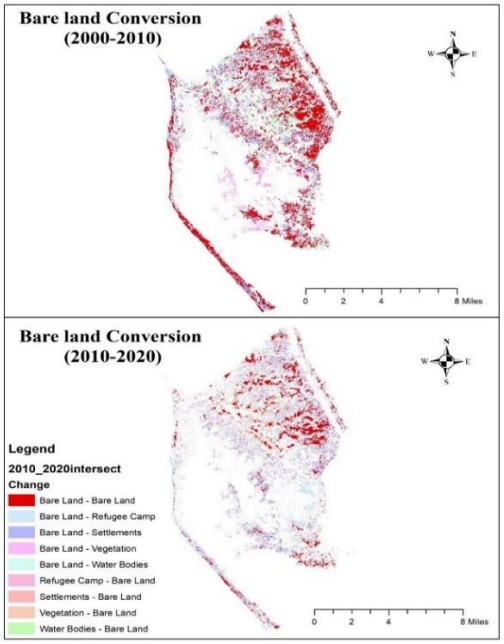

Figure: Bare land conversion map

Area statistics and relative changes of each LULC category between 2000-2010 and 2010-2020

Table: Area statistics & relative change of areas (2000-2010)

Categories	Year 2000		Year 2010		Relative change of areas between 2000 to 2010	
	Area (km^2)	% of the total area	Area (km^2)	% of total area	Changed area (km^2)	Changed area (%)
Bare land	97.32	37.68	57.79	22.37	-39.53	-15.30
Refugee Camp	0	0.00	11.82	4.58	11.82	4.58
Settlement	35.64	13.80	49.01	18.97	13.37	5.18
Vegetation	116.81	45.22	126.91	49.13	10.1	3.91
Water Bodies	8.53	3.30	12.76	4.94	4.23	1.64

Table: Area statistics & relative change of areas (2010-2020)

Categories	Year 2010		Year 2020		Relative change of areas between 2010 to 2020	
	Area (km^2)	% of total area	Area (km^2)	% of total area	Changed area (km^2)	Changed area (%)
Bare land	57.79	22.37	31.78	12.30	-26.01	-10.07
Refugee Camp	11.82	4.58	59.72	23.12	47.9	18.55
Settlement	49.01	18.97	70.95	27.47	21.94	8.49
Vegetation	126.91	49.13	90.52	35.05	-36.39	-14.09
Water Bodies	12.76	4.94	5.32	2.06	-7.44	-2.88

Transition matrix

Table: Transition Matrix & Gain, Loss in year 2000-2010

	Categories	LULC 2010 (km^2)						
		Bare land	**Refugee Camp**	**Settlements**	**Vegetation**	**Water Bodies**	**Total 2000**	**Loss**
LULC 2000 (km^2)	**Bare land**	41.22	7.08	34.87	12.90	1.25	97.32	56.10
	Refugee Camp	0	0	0	0	0	0.00	0.00
	Settlement	5.89	1.91	12.45	9.25	6.14	35.64	23.19
	Vegetation	10.65	2.65	1.62	104.76	0.13	119.81	15.05
	Water Bodies	0.03	0.18	0.07	0.01	5.24	5.53	0.29
	Total 2010	57.79	11.82	49.01	126.91	12.76	258.30	94.63
	Gain	16.57	11.82	36.57	22.16	7.51	94.63	

Table: Transition Matrix & Gain, Loss in year 2010-2020

	Classes	LULC 2020 (km^2)						
		Bare land	**Refugee Camp**	**Settlement**	**Vegetation**	**Water Bodies**	**Total 2010**	**Loss**
LULC 2010 (km^2)	Bare land	13.93	14.85	22.55	6.15	0.31	**57.79**	43.87
	Refugee Camp	2.05	5.19	3.04	0.90	0.64	**11.82**	6.63
	Settlement	13.81	17.00	14.56	2.72	0.92	**49.01**	34.45
	Vegetation	0.53	15.65	29.99	80.50	0.25	**126.91**	46.42
	Water Bodies	1.46	6.03	0.80	0.26	4.20	**12.76**	8.56
	Total 2020	**31.78**	**58.72**	**70.95**	**90.52**	**6.32**	**258.30**	139.93
	Gain	17.85	53.53	56.39	10.03	2.12	139.93	

Area Swap of LULC categories between year 2000-2010 and year 2010-2020

Table: Area Swap & gross gain, loss of LULC categories 2000-2010

LULC Class	Persistence	Gain	Loss	Total Change (Gain+Loss)	Net Change (Gain-Loss)	Absolute Value of Net Change	Swap (Total change - Absolute value of net change)
Bare land	41.22	16.57	56.10	72.67	-39.53	39.53	33.14

Refugee Camp	0.00	11.82	0.00	11.82	11.82	11.82	0.00
Settlement	12.45	36.57	23.19	59.76	13.38	13.38	46.38
Vegetation	104.76	22.16	15.05	37.21	7.11	7.11	30.10
Water Bodies	5.24	7.51	0.29	7.80	7.22	7.22	0.58
Total	163.67	94.63	94.63	189.26	0.00	79.06	

Table: Area Swap & gross gain, loss of LULC categories 2010-2020

LULC Class	Persistence	Gain	Loss	Total Change (Gain+Loss)	Net Change (Gain-Loss)	Absolute Value of Net Change	Swap (Total change – Absolute value of net change)
Bare land	13.93	17.85	43.87	61.72	-26.01	26.01	35.71
Refugee Camp	5.19	53.53	6.63	60.17	46.90	46.9	13.27
Settlement	14.56	56.39	34.45	90.84	21.94	21.94	68.90
Vegetation	80.50	10.03	46.42	56.45	-36.39	36.39	20.06
Water Bodies	4.20	2.12	8.56	10.68	-6.44	6.44	4.24
Total	118.37	139.93	139.93	279.85	0.00	137.68	142.17

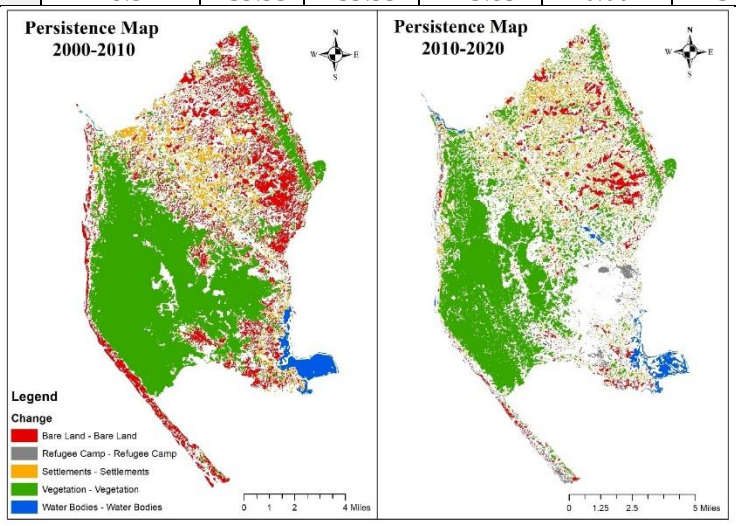

Figure: Persistence Map of LULC

Ranking 2000-2010 (High to Low)

Table: Ranking of gain, loss, persistence 2000-2010

Rank	LULC Class	Gain	LULC Class	Loss	LULC Class	Total Change (Gain+Loss)	LULC Class	Persistence
1st	**Settlements**	36.57	**Bare land**	56.10	**Bare land**	72.67	**Vegetation**	104.76
2nd	**Vegetation**	22.16	**Settlements**	23.19	**Settlements**	59.76	**Bare land**	41.22
3rd	**Bare land**	16.57	**Vegetation**	15.05	**Vegetation**	37.21	**Settlements**	12.45
4th	**Refugee Camp**	11.82	**Water Bodies**	0.29	**Refugee Camp**	11.82	**Water Bodies**	5.24
5th	**Water Bodies**	7.51	**Refugee Camp**	0.00	**Water Bodies**	7.80	**Refugee Camp**	0.00

Table: Ranking of gain, loss, persistence 2010-2020

Rank	LULC Class	Gain	LULC Class	Loss	LULC Class	Total Change (Gain+Loss)	LULC Class	Persistence
1st	**Settlements**	56.39	**Vegetation**	46.42	**Settlement**	90.84	**Vegetation**	80.50
2nd	**Refugee Camp**	53.53	**Bare land**	43.87	**Bare land**	61.72	**Settlements**	14.56
3rd	**Bare land**	17.85	**Settlements**	34.45	**Refugee Camp**	60.17	**Bare land**	13.93
4th	**Vegetation**	10.03	**Water Bodies**	8.56	**Vegetation**	56.45	**Refugee Camp**	5.19
5th	**Water Bodies**	2.12	**Refugee Camp**	6.63	**Water Bodies**	10.68	**Water Bodies**	4.20

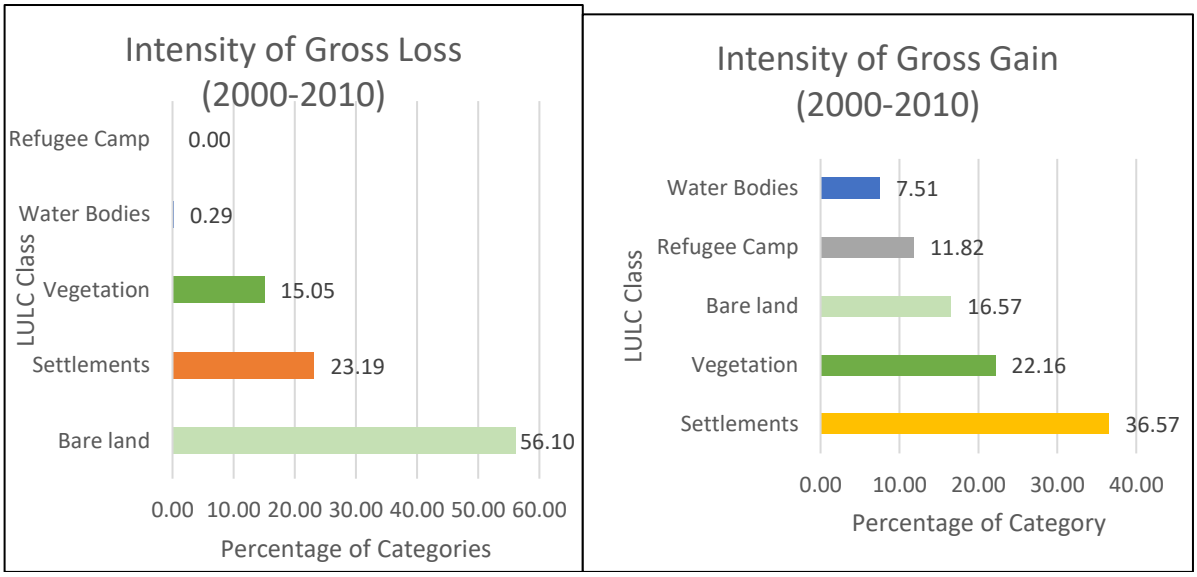

Figure: Intensity of gross loss 2000-2010 and 2010-2020

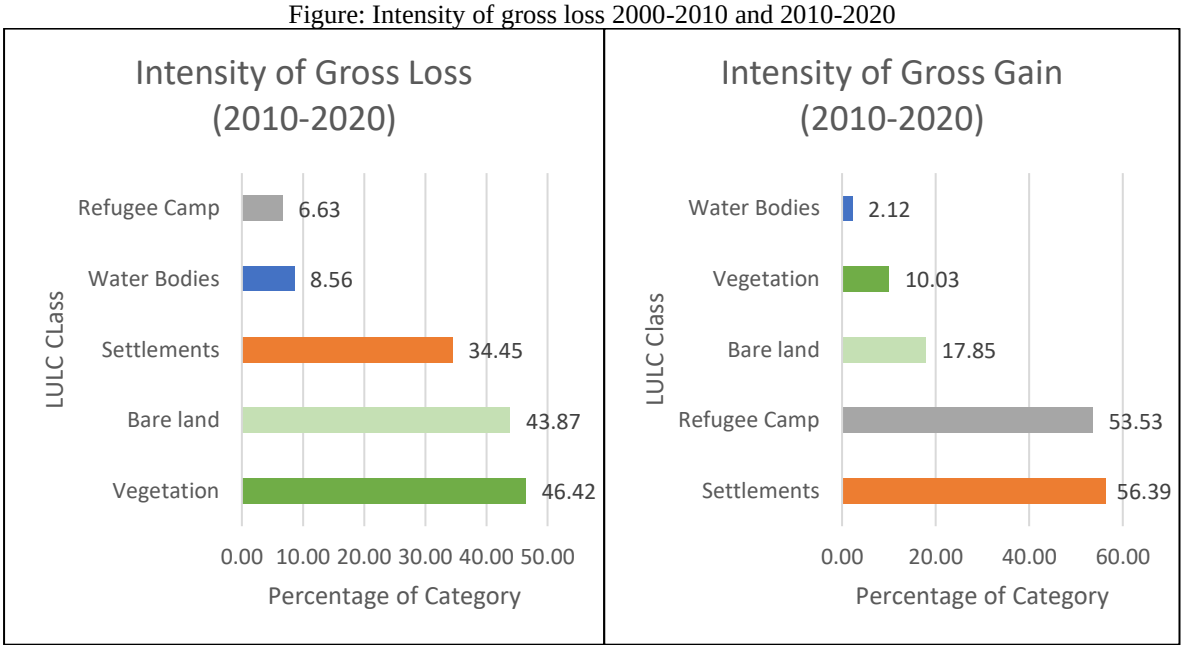

Figure: Intensity of gross loss 2010-2020

Land Change Speed Comparison

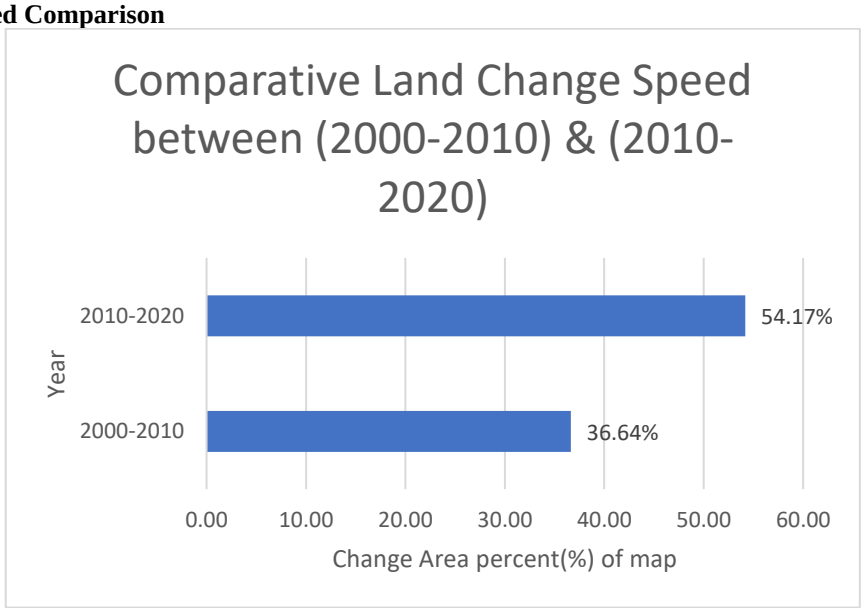

Figure: Land use change speed

Forest Cover Change Detection

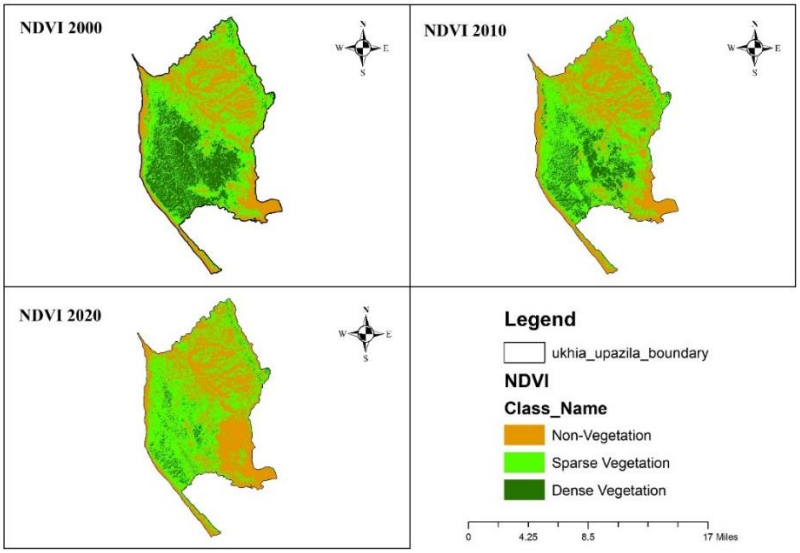

Figure: NDVI map of Ukhia

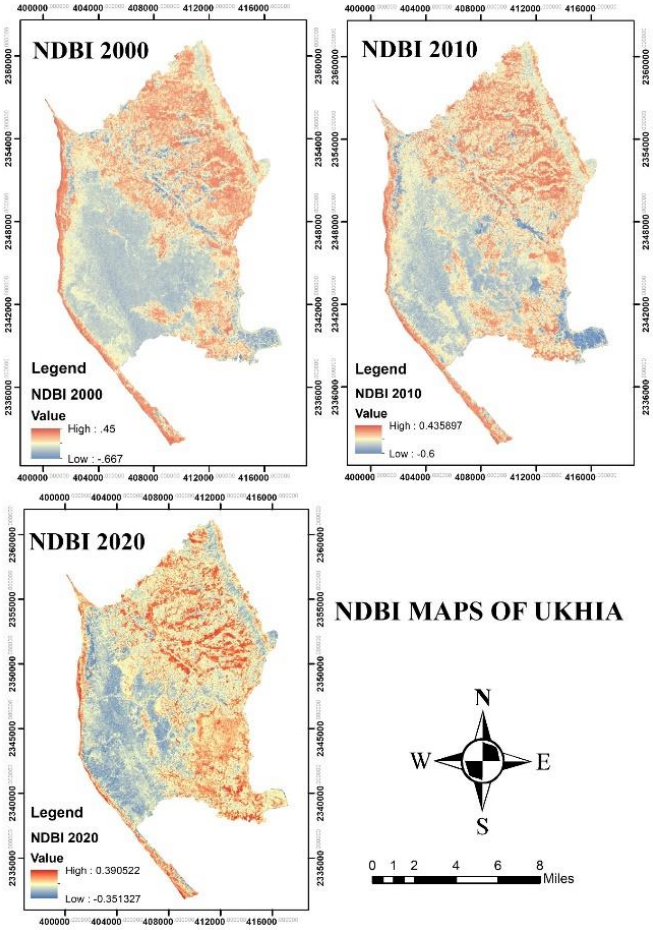

Figure: NDBI Maps of Ukhia

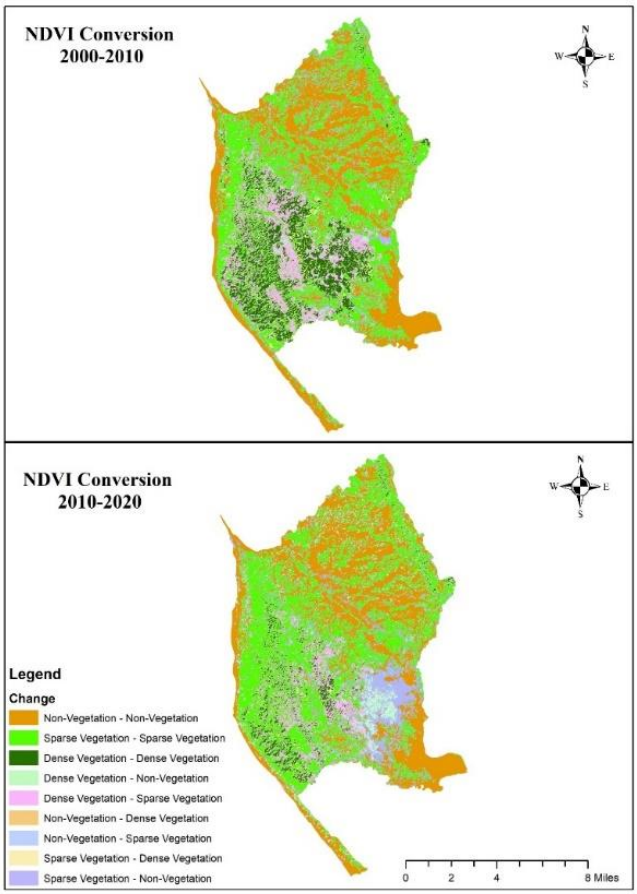

Figure: NDVI conversion map

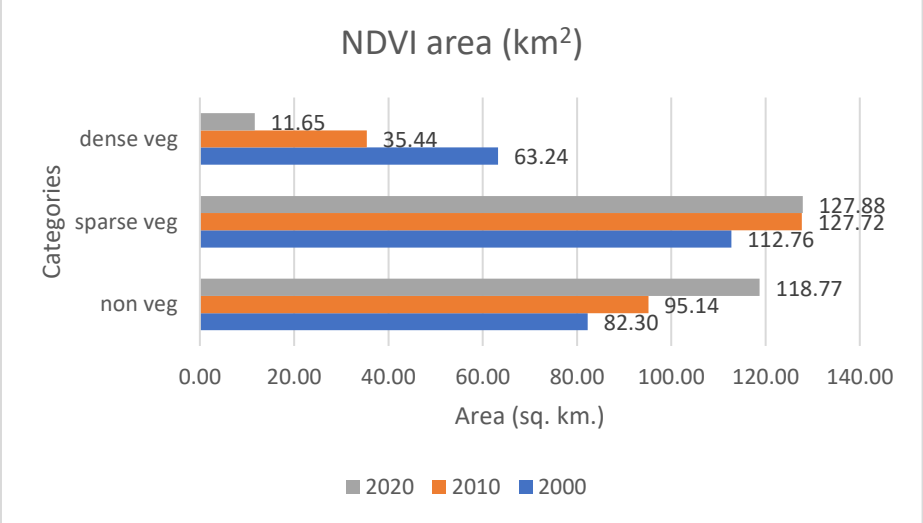

Figure: NDVI area cover

Impact on Spatial Land Surface Temperature

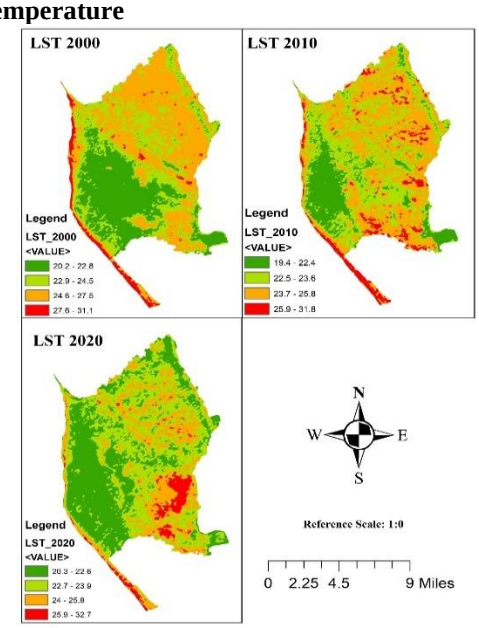

Figure: Spatial Land Surface Temperature Map

Table: Max, Min and Average LST

Land Surface Temperature (ºC)			
Year	2000	2010	2020
Min. Temperature	20.2	19.4	20.3
Max. Temperature	31.1	31.8	32.7
Average	25.65	25.6	26.5

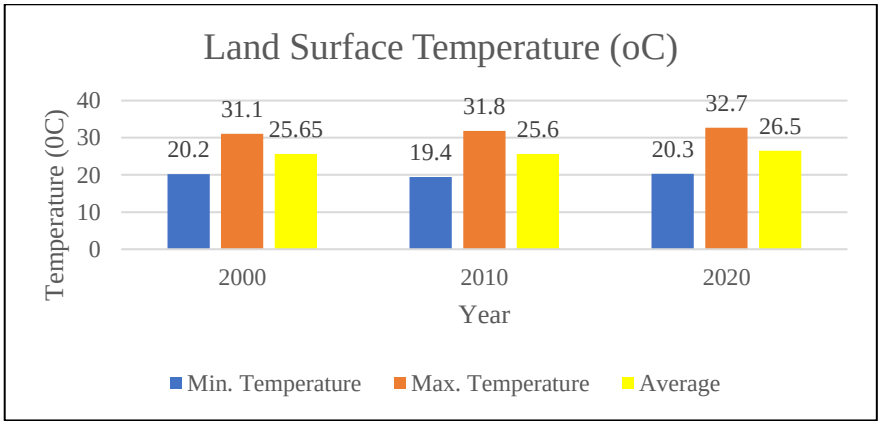

Figure: LST of year 2000,2010,2020

Correlation of LST with NDVI and NDBI

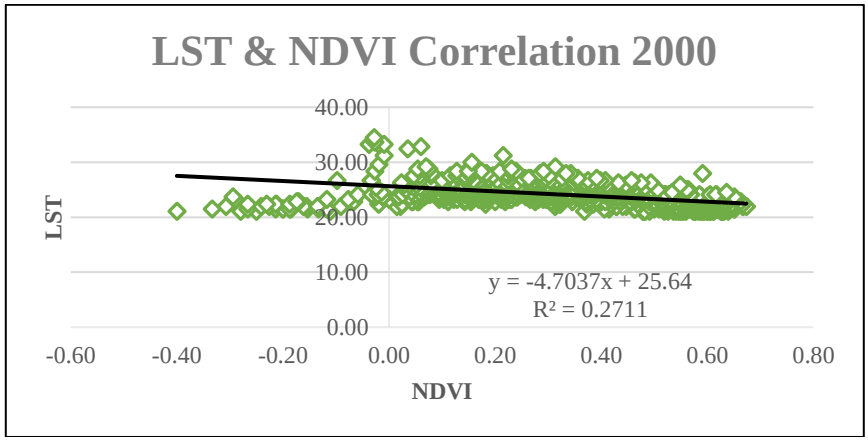

Figure: LST & NDVI correlation year 2000

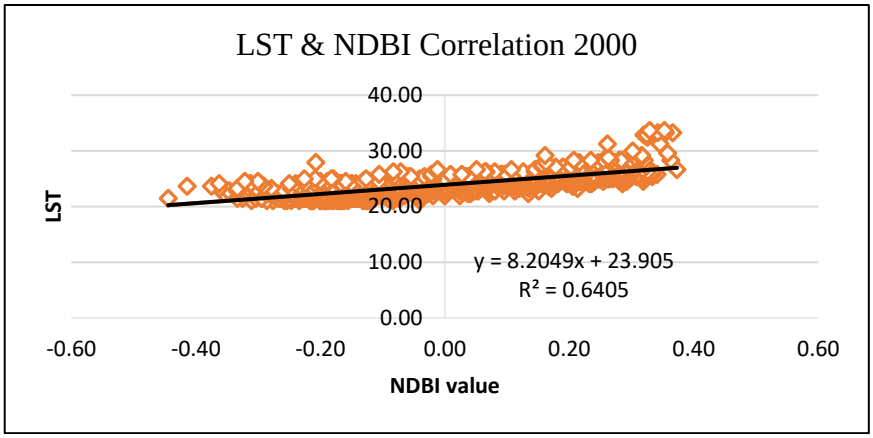

Figure: LST & NDBI correlation year 2000

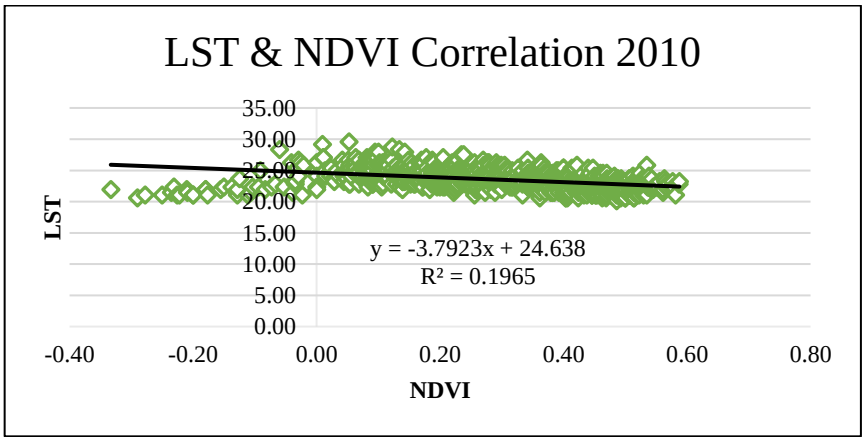

Figure: LST & NDVI correlation year 2010

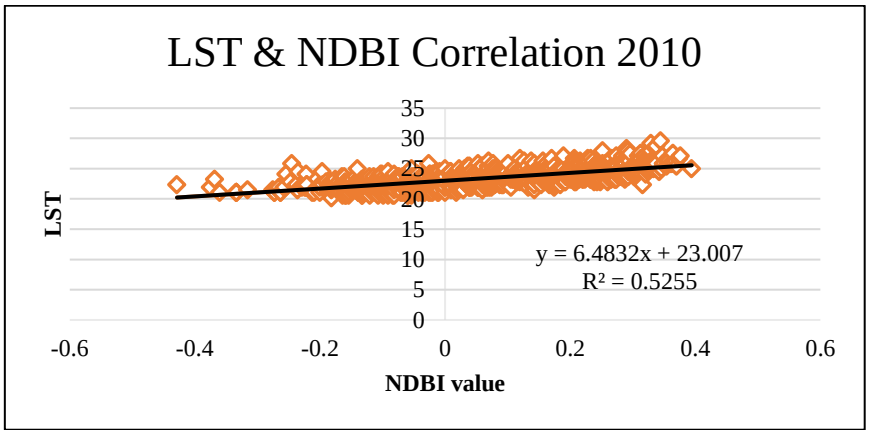

Figure: LST & NDBI correlation year 2010

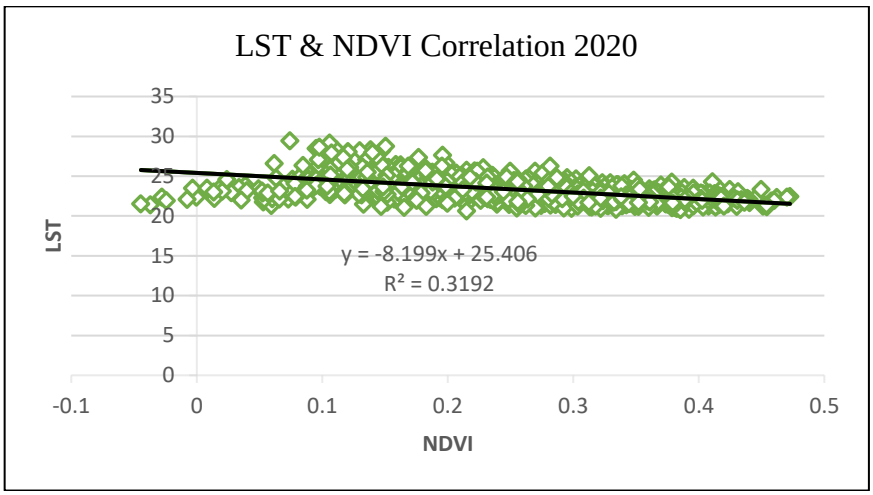

Figure: LST & NDVI correlation year 2020

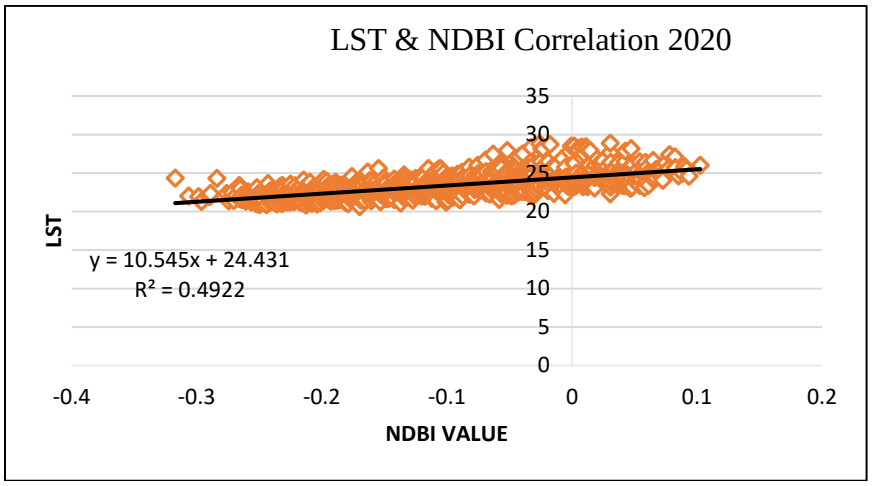

Figure: LST & NDBI correlation year 2020

Findings for Ojective 1

- Bare lands have the highest intensity of gross loss in period 2000 to 2010 and
- The settlements have the highest intensity of gross gain in between 2000 to 2010.
- But the settlements had changed most dynamically during that period.
- From 2010 to 2020, vegetation covers have the highest intensity of gross loss and
- The category which has the second highest intensity of gross loss is the bare lands.
- But in this period the most dynamic change has been noticed in the settlements and category followed by the refugee camps category.

Findings for Objective 2

- The land use change rate of year 2000 to 2010 is 3.6% per year and
- The land use change rate of year 2010 to 2020 is 5.4% per year.

Findings for Objective 3

The land surface temperature has a direct relation with the NDVI and NDBI values. The LST of Ukhia has increased from the year 2000 to 2020, as a result of decreasing dense vegetation cover and increasing the number of settlements in that area day by day. The average LST has changed from 25.65 degrees Celsius to 26.5 degrees Celsius between the years 2000 to 2020.

Conclusions:

Coastal Areas play a vital role in our demography and environment. Ukhia upazila is a coastal upazila which is geographically so important for both our ecology and economy. Because many tourist' spots are in this upazila. The most famous and visited tourist place of this upazila is the Inani seabeach. It also pays a great amount to the region's economy as tourists from the world's different corners visit this beach. The local people are greatly dependent on the tourism activities in that region of Cox's Bazar zila. Due to the Rohingya influx in that region crime rates have severely increased. Poor and desperate Rohingya people are ready to do any crime in exchange for a little provocation. So, a bad impact on the image of that region can harm the tourism sector significantly. Besides the illiterate Rohingya people are not conscious

of the fact of increasing population. It is an alarming fact for our country. Many Rohingya people are illegally becoming Bangladeshi citizens and actively joining politics. These could result in a great matter of worry for us. In this study, three objectives were taken into account to know about the actual scenario of environmental damage and its impact on an environmental parameter (Land Surface Temperature). Satellite images from three different years were taken to analyze these objectives. By completing the analysis, we came to know about the facts that From 2010 to 2020, Vegetation covers had the highest intensity of gross loss and second highest intensity of gross loss in the bare lands and the most dynamic change was noticed in the settlement's category, followed by the refugee camps category. during the period 2000 to 2010, Bare lands had the highest intensity of gross loss, settlements had the highest intensity of gross gain and the settlements had changed most dynamically between that period. The land Use Change rate was higher in the 2010-2020 period. The average LST has changed from 25.65 degrees Celsius to 26.5 degrees Celsius between the years 2000 to 2020 Not only the vegetation is damaged and the environment harmed but our socio-economic conditions in that region that been severely sloping towards danger. The government has taken some initiatives to take apart some Rohingyas to a remote place far from the locality. The relocation of almost 1 lakh Rohingya has been done to date but for the sake of our country's betterment government must consider the fact of sending Rohingya people to their original roots as they are proven a burden for us. Before it is too late, the government must take steps to send them back as the local community of Ukhia, and Teknaf are getting more and more disturbed by their activities.

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