GEOGRAPHICAL STUDY ON MANGROVE ENVIRONMENT IN TAUNGGOKE TOWNSHIP, RAKHINE STATE

Ohnmar Myat Htoo[1] and San San Khine[2]

Abstract

Mangrove refers to a particular group of tree species which thrive on the tidal estuarine delta and along the muddy riverine area and are resistant to salinity. This paper presents the geographical analysis on the mangrove environment, particularly on the distribution of mangrove species along the coastal area of Taunggoke Township. Although the mangrove forests can be found together in classified zone as same mangrove species group, in Taunggoke Township, the same mangrove species are not found in groups in specific places, but all the species are mixed up elsewhere. However, some species are more dominant among others in some places. For instance, *Rhizophora* species, particularly byu-chehtaukama (*Rhizophora mucronata*) are more common along the Kayaing River bank facing the Bay of Bengal. Many mangrove species thrive within the Taunggoke mangrove area, but 30 species are more common including 17 true mangrove species and 13 associated mangrove species. As population has been increasing during the study period, human pressure can cause mangrove degradation. GIS and Remote Sensing techniques are used for land cover changes mangrove degradation caused by agriculture and shrimp ponds in the mangrove area of Taunggoke Township in 1990, 2000, 2010 and 2020.

Keywords: *mangrove species, landcover change, mangrove degradation, Taunggoke Township*

Introduction

The word mangrove is defined variously. The Shorter Oxford Dictionary describes the word "mangrove" as obscurely connected with the Portuguese word "mangue" and the Spanish word "mangle" and the English word "grove" and it dates its origin as 1613. Since recently mangrove has been widely described as "mangrove forest", "tidal forest" and "coastal woodland". Mangrove can be trees, shrubs, palms, or ground ferns growing in the zone between high and low tide (Field, 1995).

Mangroves which thrive in areas between the land and sea within the tropical and subtropical zones form an important forest type in the coastal ecosystem.

Mangrove forest is one of the valuable natural resources, as it yields timber, firewood, and woods for making charcoal, tannin, fish, prawn, crustaceans and many other useful things. Besides, it has high productive potential for paddy cultivation and shrimp pond culture.

In this study, mangrove environment is defined the conditions of mangrove species and mangrove fauna which exist in salt water tidal condition. Distribution of mangrove species and degradation of mangrove forest of the study area are more emphasized.

The study area

The study area (mangrove area) is part of Taunggoke Township, occupying the middle portion of the Rakhine State, flanked by the Bay of Bengal in the western coastal strip of Myanmar. It is situated between the lowland and the sea, occupying one- fifth of the township area. It is latitudinally located between 18˚ 38′ North and 19˚ 20′ North and longitudinally between 93˚ 59′ East and 94˚ 18′ East. It has an area 1093 square kilometres representing 21 percent of total township area (5328 square kilometres).

[1] Dr, Professor, Department of Geography, Kalay University
[2] Dr, Professor, Department of Geography, Taunggoke University

The major creeks which drain through the study area are the Taunggoke, Tanlwe, Sabyin, Lamu and Ma-i taking their sources from the Rakhine Yoma. A number of streamlets join these creeks.

The mean annual temperature of the Taunggoke Township is 25.93˚C. The normal annual rainfall is 5371 mm. According to Koppen's climatic classification the area experiences Tropical Monsoon climate (Am).

Materials and Methods

In order to have the mangrove area (Study Area) in Taunggoke Township, one-inch topographic maps (No. 85 I and J, 1944) are scanned, formatted by Geographical Information System (GIS). Then the mangrove area is obtained by digitizing the mosaic map.

For land cover type changes, the Landsat TM Images taken in February, 1990, 2000, 2010 and 2020 are processed, georeferenced and classified, and village tracts land cover change data are obtained by overlaying village tract boundaries. The information concerning economic activities that cause land cover change and mangrove forest degradation are acquired through field surveys in village located within the mangrove area and from interviews with certain local people.

Research problem

The chief problems related to mangrove forests are over exploitation, the extension of more profitable economic activities and loose and less effective forest management which all lead to mangrove forest degradation and deforestation.

Aim

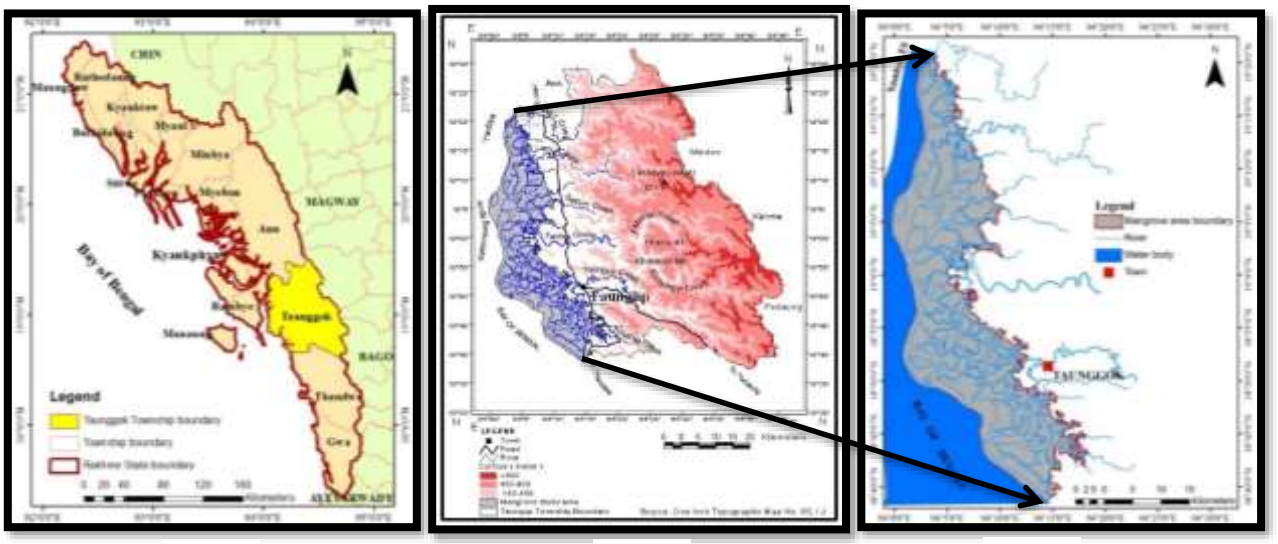
The main aim of this research paper is to give suggestions for mangrove forest management in a sustainable long-term basis.

Objectives

The main objectives of this research are:

(1) To study the classification of mangrove species depending on the water condition in the study area

(2) To analyze the mangrove forest degradation and deforestation within the study area



(a) **(b)** **(c)**

Source: One Inch Topographic Map No. 85, I J, DEM

Figure 1 (a, b and c) Location of Mangrove area in Taunggoke Township within Rakhine State

Finding

Characteristics of Mangrove

Mangrove trees and shrubs are a common sight on mudflats and banks of tropical and subtropical coastlines in many parts of the world.

In the study area, some of the spatial distributions of mangrove species are presented below and others have not been studied in detail.

Madama (*Ceriops decandra*)

This species is found as shrub or small slender trees. It has a height of 2 to 4 metres and is usually found together with scattered kanazo (*Heritiera fomes*) or thayaw (*Excoecaria agallocha*) in area where the freshwater and saltwater meet. It is mostly dominant in Kalayaung, Sabyin, Kaleintaung and Ashebet villages. The local fishermen commonly use madama (*Ceriop decandra*) for conical fishing net (locally known Ar-htauk-pike), fenced fish-trap, Jelly fish ponds and firewood and charcoal.

Byu-shwewa (*Bruguiera sexangula*) and Byu-che htaukapo (*Rhizophora apitulata*)

The species exhibit as trees and are found along the place where the freshwater merge with saltwater. In the northern part of the study area, particularly along the Ma_i, Lamu, Kama, Pada and Sabyin creeks, these species appear as a mixed forest with kanazo (*Heritiera fomes*) and thayaw (*Excoecaria agallocha*) which are large in size. They thrive in area affected by occasionally tide only. The tree species with barks are useful for making liquid dye. Tanning by dye obtained from the bark of trees also causes the destruction of mangrove species in the mangrove forest area.

Byu-chehtaukama (*Rhizophora mucronata*)

This species thrives in high salinity area and along the contact zone between freshwater and saltwater. They have stilt roots at the foot of the stem. They are usually found as small trees in group along the Kayaing Creek facing the Bay of Bengal in the southern part of the study area,

though thamephyu (*Avicennia marina*) are often spotted among them. In the northern part, the stem of the tree is larger and they grow sporadically in patches.

Kantbala (*Sonneratia apetala*)

This kind of mangrove species grows in moderately salinity water and along the place where freshwater and saltwater meets. They are found as large tree along the tributaries of Kama, Lamu, and Tanlwe creeks, often mixed up with thayaw (*Excoecaria agallocha*) and Lamu (*Sonneratia caseolaris*). It is used for building materials.

Madama (*Ceriops decandra*)

Kantbala (*Sonneratia apetala*)

Byu-chehtaukama (*Rhizophora mucronata*)

Byu-shwewar (*Bruguiera sexangula*)

Kanazo (*Heritiera fomes*)

Thinban (*Hibiscus tiliaceus*)

Source: Author field observation

Plate 1 Common type of mangrove species in the study area

Kaya (*Acanthus illicifolius*)

Pinleohn (*Xylocarpus granatum*)

Wetla Grass (*Scirpus grossus*)

Dani (*Nipa fruticans*)

Source: Author field observation

Plate 1 Common type of mangrove species in the study area

Pinleohn (*Xylocarpus granatum*)

Pinleohn thrives in high salinity area and mostly found along the Kayaing Creek in the southern part especially in near Kayaing and Kande villages. Pinle-ohn (*Xylocarpu granatum*) and its fruits are used in tanning as it also has a high of tannin content.

Dani (*Nipa fruticans*)

Dani is a kind of palm with underground stem and usually grows in places where freshwater mixes with saltwater. In the northern part, they are found along the banks of creeks. Near the dani grove, *Sonneratia* or *Avicennia* species are found scattering widely. Kaya (*Acanthus ilicifolius*) or hnetkyitaung (*Acrostichum aureum*) usually forms as undergrowth.

Nipa palm species is useful in many respects and it also prevents bank erosion. However, the cultivation or the extension of *nipa palm* in the mangrove area causes contraction of mangrove area and depletion of mangrove trees.

Plants and Environment Interaction in the Study Area

The spatial variation of mangrove species is influenced largely by topography, seasonal rainfall, drainage system, tide, salinity and elevation of ground.

Topography

The southern part of the study area, especially the coastline facing the Bay of Bengal near Panhtaw Island is windy and inundated by wave action which gives rise to sandy soils and sand dune forests characterized by casuarina, coconut and other trees mixed with thick bushes. There are small hills, mountain spurs and uplands near Kayaing Village, which are the westward

extensions of the Rakhine Yoma. Between these uplands are low valleys along which a number of streams flow. In this part, the mangrove forests are confined to the stream banks and mixed with other non- mangrove species. The larger area of mangrove forests is found in the northern part where the flatlands are fairly extensive, particularly near Lamu, Chetpauk, Sabyin, Letpankyun villages, and Sapagyi and Zee islands of the upstream Kaleintaung River.

Table 1 Common Mangrove Species in the Study Area of Taunggok Township

No.	Botanical Name	Family	Myanmar Name	Vernacular Name	Type of Tree	Group
1	*Ceriops decandra*	Rhizophoraceae	madama	Kabaing	Small tree	T
2	*Bruguiera sexangula*	Rhizophoraceae	byu-shwewar	Tokepin	Tree	T
3	*Rhizophora mucronata*	Rhizophoraceae	byu-chedaukama	byu-phyu	Small tree	T
4	*Rhizophora apitulata*	Rhizophoraceae	byu-chedaukapo	byu- me	Tree	T
5	*Xylocarpus moluccensis*	Meliaceae	kyana	Panan	Tree	T
6	*Xylocarpus granatum*	Meliaceae	Pinleohn	Yeohn	Tree	T
7	*Sonneratia apetala*	Sonneratiaceae	kantbala	pyarsay pin	Tree	T
8	*Sonneratia caseolaris*	Sonneratiaceae	lamu	Lamu	Small tree	T
9	*Sonneratia griffithii*	Sonneratiaceae	laba	Linbike	Tree	T
10	*Avicennia alba*	Avicenniaceae	thamekyettet	Pyarme	Small tree	T
11	*Avicennia marina*	Avicenniaceae	thamephyu	Pyarphyu	Small tree	T
12	*Excoecaria agallocha*	Euphorbiaceae	thayaw	kyekan	Tree	T
13	*Heritiera fomes*	Sterculiaceae	kanazo	Yesoe	Tree	T
14	*Aegiceras Comiculutum*	Myrsinaceae	yekayar	Jetthalone	Small tree	A
15	*Hibiscus tiliaceus*	Malvaceae	thinban	Saban	Shrub	A
16	*Brownlowia tersa*	Tiliaceae	yethaman	Chusan	Shrub	A
17	*Dalbergia spimosa*	Leguminosae	byaiksu	Salesu	Shrub	A
18	*Derris scandens*	Leguminosae	migyaungnwe	migyaung new	Climber	A
19	*Caesalpinia crista*	Leguminosae	alolay nwe	saleiknwe	Climber	A
20	*Derris trifoliata*	Leguminosae	homenwe	homenwe	Climber	A
21	*Nipa fruticans*	Palmae	dhani	ohn	Palm	T
22	*Phoenix paludosa*	Palmae	thinbaung	sabaung	Palm	T
23	*Acrostichum aureum*	Filiceae	Hngetgyidaung	hmohin	Fern	T
24	*Acanthus ilicifolius*	Acanthaceae	kaya	hpetyan	Shrub	T
25	*Flagellaria indica*	Flagellariceae	yekyein / wetkyein	myaukkyein	Climber	A
26	*Finlaysonia maritima*	asclepiadaceae	byauknwe	newboke	Climber	A
27	*Finlaysonia ovobata*	asclepiadaceae	thikekalein	theikkalein	Climber	A
28	*Sesuvium portulascastrum*	Airoaceae	_	kyechar	Grass	A
29	*Cyperus tegitiformis*	Cyperaceae	_	thabaukza	Grass	A
30	*Scirpus grossus*	Cyperaceae	wetla	wetla	Grass	A

Source: Author observation and based on Mangroves of the Sundarbans, VII: Bangladesh, IUCN (1994)

T = True Mangrove
A = Associated Mangrove

Seasonal Rainfall

Ninety eight percent (98%) of the annual rainfall occurs during the monsoon season from May to October. Frequent and heavy rains occur from June to August.

For optimum growth, mangroves require a certain amount of fresh water, even though these species are salt tolerant (halophyte). Rain water regulates salt concentration in soil and plants, in addition to fresh water discharged by the stream. Reduction of salt content enhances the physiological function of the mangrove species.

Drainage System

The creeks flowing through the study area have dendritic pattern which can carry a large load of sediments to the lower reaches. Combined with the tidal circulation at the mouths of the creeks that have flannel shape, it increases the rate of sedimentation which over time forms mud flats over which the mangrove species thrives.

Tide

Tide is one of the important factors for the zonation of plant, the growth and survival of mangroves. The tidal action mixes up the saltwater from the sea and freshwater from the rivers along the coast line. Salinity of coastal water changes notably at the spring tide and neap tide. This change, in turn leads to the variation of mangrove species, the girth and height of trees and spatial distribution of the mangrove forests. Tidal duration has similar effects on species distribution, vegetation structure and function of mangrove ecosystems. Tide is regular rise and fall twice each in a day in the coast line of Taunggoke mangrove area. In the coastal area of Taunggoke Township, the range of spring and neap tide is from 8 to 12 feet. The upper tidal limit reaches 12 feet, and it is usually highest in November.

Salinity

The salinity of river water within the study area is measured by Refractometer which shows the degree of salinity by g/100g, i.e, the weight of salt soluted in 100 grammes of salty water.

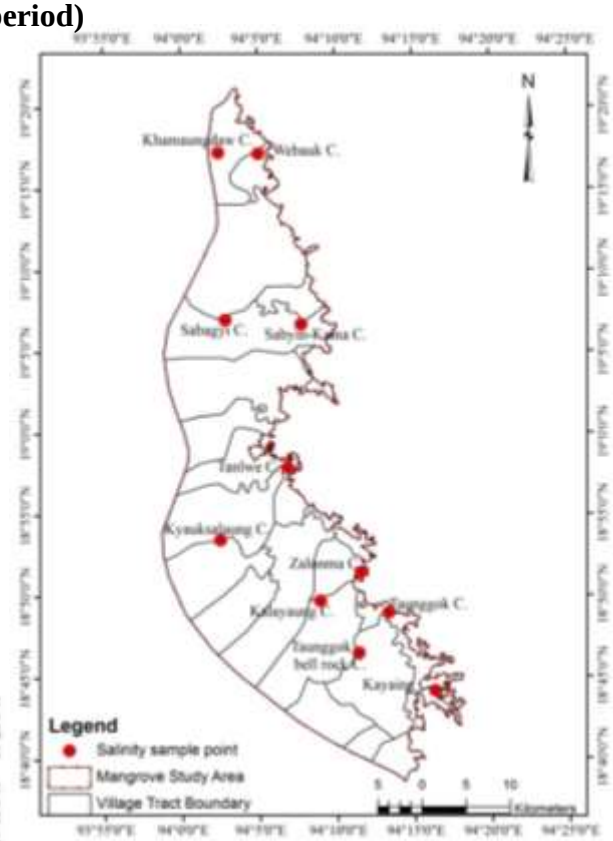
Salinity has its influence on the growth rate, size and distribution of mangrove species. Surface water salinity is largely related to the distance to the sea, tidal action and seasonal rainfall. The water in the upstream distant from the sea is low in salinity. According to the result of salinity measurement in the pre-monsoon period (March_ April in 2019) it is 3g/100g in the upstream of Kayaing Creek near Moe Village, 2.3g/100g in the upstream of Taunggok Creek near Thaleinbyin Village and 2.1g/100g in the upstream of Tanlwe Creek near Ngalonemaw Village. Salinity increases (3.7g/100g) toward the downstream. It is between 2.5g/100g and 3.5g/100g along the main course of Kaleintaung River. In the post-monsoon period (August-September in 2019), the fresh water from Rakhine Yoma drains into the streams and thus the salinity of the river water decreases to 0.3g/100g.

High salinity affects the size of mangrove tree. The tree size is relatively larger in the eastern and northern parts where salinity is low. In the southern part such species as kanazo (*Heritiera fomes*), kantbala (*Sonneratia apetala*), thayaw (*Excoecaria agallocha*), and *Rhyzophora* species are stunted because of high salinity.

Table 2 Some salinity values (Pre-monsoon period) in the study area

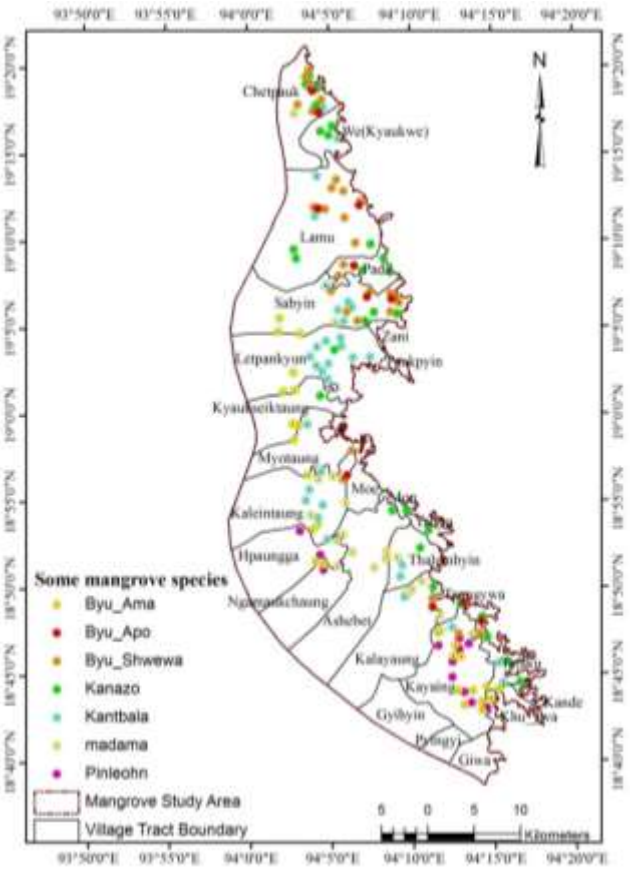
No.	Creek Name	Salinity Value g/100g
1	Webauk Creek	1.7
2	Khamaungdaw Creek	1.8
3	Sabyin-Kama Creek	2
4	Sabagyi Creek	2.9
5	Kyauksalaung Creek	3.6
6	Zalonma Creek	2.5
7	Tanlwe Creek	2.1
8	Taunggok Creek (up stream)	2.3
9	Taunggok Creek (down stream)	3.7
10	Kalayaung Creek	3.5
11	Kayaing Creek	3

Source: Author observation



Source: Based on table 2

Figure 2 Some salinity values of the study area



Source: Author observation and information from local people

Figure 3 Distribution of some mangrove species

Zonation of Mangrove Species

Frequency of tidal inundation is directly related to the ground elevation and it is one of the prime factors in the distribution of mangrove species. Tidal inundation may be less frequent if the ground surface level is higher than sea level. Consequently, the species that thrives in such area

would be different from the species that grow on low ground level often frequented by tidal inundation. The land frequented by tidal action can be classified as low ground area, medium ground area and high ground area.

Low Land Area

According to Watson's data (1928), the low ground area experiences all high tide and medium high tides and thus tidal inundation occurs every day. It is the land portion with muddy surface where new sediments are deposited by streams. The elevation of the area is between mean sea- level and 3.4 metres, and the monthly frequency of tidal inundation is between 45 and 62 times.

The most common species in the low land ground of Taunggok mangrove area are byu-che htaukama (*Rhizophora mucronata*), byu-che htaukapo (*Rhizophora apitulata*), byu-shwewa (*Rhizophora sexangula*), thamegyi (*Avicennia alba*), thamephyu (*Avicennia marina*), thamegyi (*Avicennia officinalis*), kantbala (*Sonneratia apetala*), lamu (*Sonneratia caseolaris*), laba (*Sonneratia griffithii*), pinle-ohn (*Xylocarpus granatum*), kyana (*Xylocarpus molucensis*), dani (*Nipa frutican*), thinban *(Hibiscus titiaceous*) and such bush species as kayar (*Acanthus ebracteatus*) and hngetgyitaung (*Acrostichum aureum*). The dominant climbers are migyaungnwe (*Derris scandens*), myauknwe (*Finlaysonia maritime*), and byaiksu (*Dalbergyi spimosa*). Grasses occupy the area as pioneer species; thabautza (*Cypernus tegitiformis*) and wetla grass (*Scirpus grossus*) are most common. The area is favourable for shrimp culture.

Medium Land Area

The medium land area is the area between high tide and spring tide limit with elevation between 3.4 m to 4.6 m above mean sea- level. The area experiences 2 to 45 times of tidal inundation in a dry month. The area has most of the species found within the study area. In addition to the species that thrive in the low land area, madama (*Ceriops decandra*), madamamyaw (*Ceriops tagal*), thinban (*Hibiscus tiliaceous*), kyana (*Xylocarpus moluccensis*), kanazo (*Heritiera fommes*), yekayar (*Aegiceras corniculatum*), thinbound (*Phoenix paludosa*), ehitmathwe (*Luminitzera littorea*) and yethaman (*Brownlowia tersa*) are also observed in this area. The varieties of weed species, climbers and grasses are the same as found in the low land area. The presence of low land mangrove species in this area is owing to being a low land in the past and the pioneer species continue to thrive with the gradually rising land by deposition. Since the medium land area has a variety of species, some of them can be extracted commercially. Besides, the area is also favourable for the paddy cultivation.

High Land Area

The high land area, according to inundation data of Watson has an elevation between 4.6 m above the mean sea- level. The area experiences tidal inundation twice a month in the spring tide periods. Sometimes, the area becomes inundated due to abnormally rising high tide. The low frequency of tidal inundation results in low soil moisture content than that of the low and medium land areas. Accordingly, such low- moisture resistant species as kanazo (*Heritiera fomes*), madama (*Ceriops decandra*), madamamyaw (*Ceriops tagal*), thayaw (*Excoecaria agallocha*), hngetkyitaung (*Acrostchum aureum*), yekyein or wetkyein (*Flagellaria indica*), alolaynwe (*Caesalpinia crista*), migyaungnwe (*Derris scandens*) and wetla grass (*Scirpus grossus*) are more common. Thus, the area is also favourable for the paddy cultivation.

Mangrove Fauna

In contrast to terrestrial environment, mangrove environment is characterized by swampy ground and more or less salty water and thus it is not a favourable habitat for terrestrial animals. Some terrestrial animals are now nearly extinct owing to human pressure.

In fact, Taunggoke mangrove area is the zone where freshwater from the streams mixes with the salty water of the open sea. Thus, it serves as feeding ground for both freshwater fish and sea water fish which enhance the fishing industry. The area has diverse fish species and some are greater in population. The most common fish species are hilsa (ငါးသလောက်) (*Hilsa ilisha*), thread fin (ကတ်ကူရံ) (*Polynemus spp*), giant sea perch (ကတ်ကတစ်) (*Latrs calcarifer*), blood -red snapper (ငါးပါးနီ) (*Lutjanus spp*), white pomfret (ငါးမုတ်ဖြူ) (*Pampus argenteus*), black pomfret (ငါးမုတ်မဲ) (*Parastomateus niger*), shark, sharpnose string ray (လိပ်ကျောက်နီ, cow-nosed ray (လိပ်စွန်) (*Rhinno pterus javanicus*), spanish mackerel (ငါးကွင်းရှပ်) (*Cybium guttatum*), striped dwarf catfish (ငါးစင်ရိုင်း) (*Mystus vittatus*), jelly fish (ရေခူ).

Other important aquatic species is shrimp mostly inhabiting in the streams. The common shrimps are striped, witch prawn (ပုဇွန်ကြား) (*Penaeus canaliculatus*), giant tiger prawn (ပုဇွန်ကြားအမဲ) (*Penaeus monodon*), and banana prawn (ပုဇွန်ဖြူ) (*Penaeus merguiensis*). In the rainy season the stream water becomes less salty or freshwater and this condition attract freshwater prawn (ရေချိုပုဇွန်) (*Macrobrachium rosenbergii*).

There are 6 crab species. These are musk-crab (သဲဂဏန်း) (*Charybdis cruciata*), three sport-summing (ဝသုံးလုံးဂဏန်း) (*Portunus sanguinolentus*), blue summing crab (ဂဏန်းပြာ) (*Portunus pelagicus*), meder's mangrove (မျောက်ချီးစားဂဏန်း) (*Secarma pelagicus*), mud crab (ရွှံဂဏန်း) (*Scylla serrata*) and varuna litterata (ဖောင်စီးဂဏန်း).

Other hard crust species are clams (ကုံး), oysters (ကရု), mussels (ကမာ) and edible molluses like telescopium (မရွတ်). Some of these species have become less production in the mangrove forest of the study area.

Mangrove Depletion Affecting the Land Cover Change

A greater part of Taunggoke Township is hilly and mountainous. Combined with extensive marshy area, there is little land left suitable for cultivation. Even then, agriculture sector plays an important role in the economy of the township. The extension of paddy land in the mangrove forest is one of the main causes as well as the dominant cause of forest depletion.

Plate 2 Encroachment of Paddy Lands within Mangrove Forest

Plate 3 Cutting Mangroves to make Shrimp Pond and some fishing materials

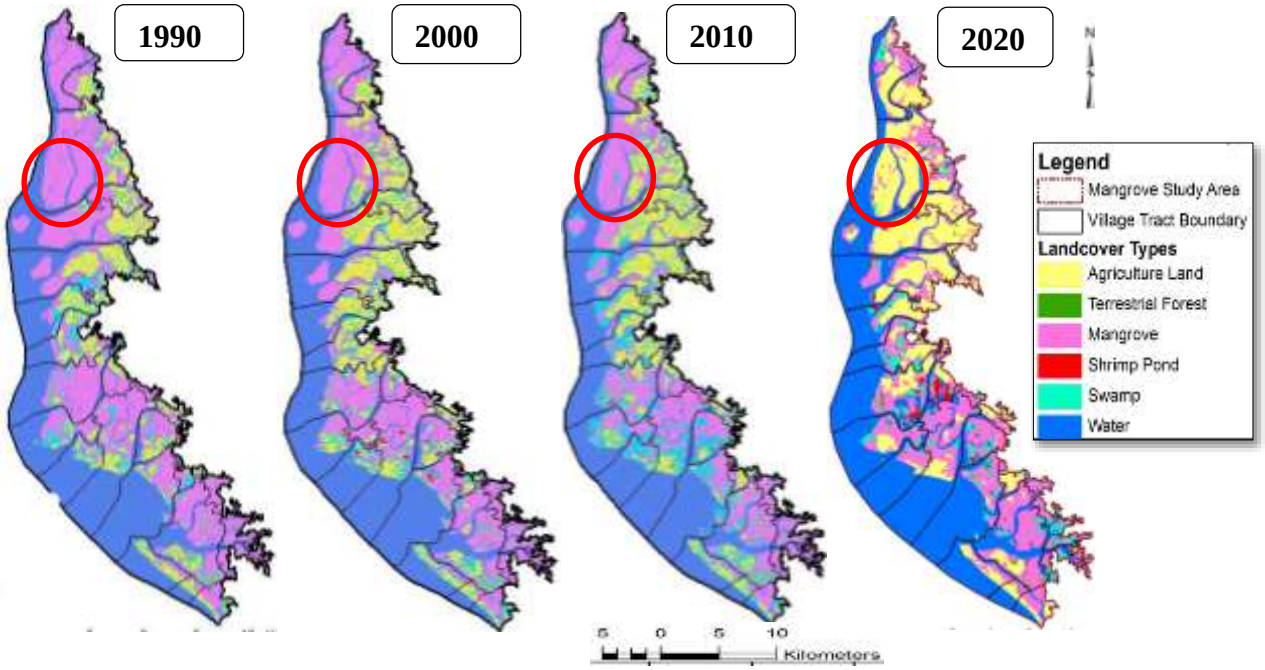
Shrimp culture is the second most important activity in Taunggoke Township. Making of some fishing instruments and shrimp culture are one of the chief causes of mangrove forest depletion. For making certain fishing instruments such as (Conical fishing net, Pole holding net, Fish-trap, Fence fish- trap and Jelly fish pond), the necessary wooden poles are extracted from the mangrove forest.

The mangrove forest within the study area has decreased from 42296 hectares in 1990 to 35873hectares in 2000, 33415hectares in 2010 to 29567 hectares in 2020 which accounted for (27.1) percent of the study area, due to the conversion from mangrove forest into paddy land and shrimp pond land. In figure 4, the red circle shows obviously the depletion of mangrove forest converted into the paddy land in Zee Kyun of Lamu Village tract.

Table 3 Land cover change of Taunggoke mangrove area from 1990 to 2020

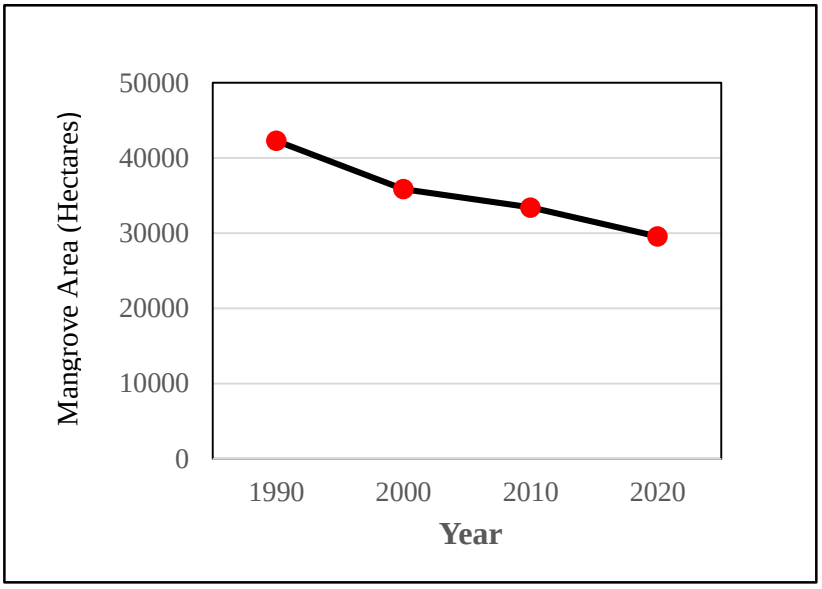
Types of Landcover	1990		2000		2010		2020	
	Total hectares	% of Study area	Total hectares	% of Study area	Total hectares	% of Study area	Total hectares	% of Study area
Agriculture	12717	11.63	18646	17	19882	18.1	27991	25.6
Terrestrial Forest	2882	2.64	2047	1.89	2067	1.8	1364	1.2
Mangrove	**42296**	**38.69**	**35873**	**32.8**	**33415**	**31**	**29567**	**27.1**
Shrimp Pond	_	_	324	0.3	311	0.3	844	0.8
Swamp	6392	5.85	7614	7	8101	7.2	4711	4.3
Water body	45039	41.2	44822	41	45550	41.6	44849	41
Total	109326	100	109326	100	109326	100	109326	100

Source: Calculated on Landsat TM Images



Source: Image processing generated from Landsat TM

Figure 4 Land cover change of Taunggoke mangrove area from 1990 to 2020



Source: Based on Table 3

Figure 5 Degradation of mangrove area from 1990 to 2020

Conclusion and Suggestions

Mangrove species vary depending on differing characteristics of the zone. In the study area, 17 true mangrove species and 13 associated mangrove species are observed.

The main cause of mangrove forest degradation within the study area is the extension of paddy land. When the yield decreases after cultivated three years in a plot, the paddy cultivators abandon the land and started work at another place removing all the vegetation. Such shifting practice should be strictly prevented. Thus, the farmers should modify the old land and use

necessary fertilizers to boost the yield. In tilling the hardened soil, they should use small tractor instead of draught animals with the help of the government.

The second type of economic activity that destroys the mangrove forest is the conversion of mangrove forest land into ponds for shrimp culture. So, the authority concerned should restricted further extension of shrimp pond land and the conversion of paddy land to shrimp pond land and vice versa.

The slightly increase of population in the mangrove study area enhances directly or indirectly the degradation of mangrove species and landcover change. The population of the mangrove study area has been steadily increasing. The study area comprises 27 village tracts. In 1983, it had 47759 people which accounted for 51.19 percent of the total population (93294 persons) of Taunggoke Township. The population increased to 70296 in 2010 which represented 47.1 percent of the township (149339 persons). In 2020, the population reached 74487 representing 48.1percent of the total population (154837 persons) of the township. The area gained 4191 more people and then the growth rate averages 0.6 percent in 10 years.

Several researchers conducted research on mangrove species. Some researchers reveal the relationship between mangrove forest and the climatic change. "Most obligate mangroves have a C_3 pathway for carbon fixation during photosynthesis" (Clough et.al., 1982) and the consensus views that such plants will increase their productivity under enhanced CO_2 partial pressures. In other studies, carried out on mature trees of *Bruguiera parviflor* (byu-kyet tet), *Bruguiera gymnorhiza* (byu-u-ta lone) and *Rhizophora apiculata* (byu-chehtaukapo) in the field, it was found that the intercellular CO_2 concentration commonly decreased with increasing rates of net photosynthesis". Removing CO_2 from the atmosphere depends on the life span, height, girth of mangrove species. For example, if an average 10 years old mangrove tree (5 metres height and 25 centimetres girth), it removes 394 lbs of CO_2 from the atmosphere. However, no research has been so far conducted concerning with CO_2 in the mangrove forest of the study area.

According to the data, there are 160145 hectares (395726 acres) of mangrove forest in Rakhine State, among them, 33943 hectares (83876 acres) in Thandwe District and 29567 hectares (73062 acres) in the study area of Taunggoke Township representing 18.46% of the State in 2020.

There are several mangroves reserved forests in Myanmar, including Wunbaik Mangrove Reserved Forest in Yambye Township of Rakhine State, Ayeyarwady Delta Mangrove Reserved Forest and Tanintharyi Coastal Reserved Forest. Reforestation of mangrove forest has been carried out in these reserved forests by systematically replanting the mangrove saplings in the depleted areas. Therefore, the mangrove forest in Taunggoke Township should be constituted as reserved forest so as to be able to effectively protect it.

The local people are less aware of the importance of mangrove forest. Some villages of 27 village Tracts depend on firewood or charcoal for cooking. The cutting of trees for firewood and charcoal making is also accountable for the degradation and depletion of mangrove forest. So, village-wise educative talks should be launched to increase awareness and interested in conserving the valuable natural resources. The collapse of the banks of river and creek is primarily due to cutting of mangroves and such indiscriminate cutting should be prohibited with effective law enforcement.

Acknowledgement

I would like to express my sincere and profound gratitude to all my teachers who assisted me in preparing this research paper. I owe special thanks to the staff of offices and local people of Taunggoke Township for aiding me in the collection of data concerned and their help in my field work.

References

Aksormkoae, S. 1993. Ecology and Management of Mangroves. IUCN, Bangkok, Thailand.

Chaudhur, A.B and A. Choudhury. 1994. Mangrove of the Sndarbans. Volume one: India. IUCN, Bangkok,Thailand.

Clough, BF., T.J. Andrews, and I.R. Cowan. 1982. Primaru Productvity in Mangroves. In, Clough, B.F. (ed)Manrove Ecosystem in Australia-structure function and management. AIMS with ANU Press, Canberra, Australia.

Field. C. D. 1995. Journey Amongst Mangroves. International Society for Mangrovre Ecosystems, Okinawa, Japan.

Https:// moretree.eco>Blog

Watson, J. P. 1928. Mangrove Swamps of the Malayan Peninsula, Malayan Forest Records. 6: pp.1-275.

ကြည်ကြည်တင့်၊ မ (၁၉၈၇) တောင်ကုတ်မြို့နယ်၏ ဒေသန္တရ ပထဝီဝင်၊ ရန်ကုန်တက္ကသိုလ် ။

တောင်ကုတ်မြို့နယ်ပထဝီဝင်အနေအထား၊ တောင်ကုတ်မြို့နယ်အုပ်ချုပ်ရေးမှူးရုံး ။

မြတ်ဆွေ၊ဝင်းညွန့်၊(၂၀၁၉) ရခိုင်ကဒီရေတောများကိုထိမ်းသိမ်းရန်လိုအပ်နေ၊ဆောင်းပါး၊စစ်တွေမြို့၊ရခိုင်ပြည်နယ်။

စိုက်ပျိုးရေးနှင့်လယ်ယာမြေစီမံခန့်ခွဲရေးနှင့် စာရင်းဇယားဦးစီးဌာန ၊ တောင်ကုတ်မြို့နယ် ။