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Contents

Geography

STUDY ON PROLONGED FLOOD IN THABAUNG TOWNSHIP, AYEYARWADY REGION*

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Abstract

Except the western part of the township, the remaining area is situated on the deltaic region. Therefore, 58.96% of the township is a hilly and 41.04% is flood plain region. The main river is Ngawun. It is the first distributary and divert from the western side of the Ayeyarwady River. The main tributaries of Ngawun River are Tabu Creek, Shwenyaungbin Creek and Daga River from the east and Kyeintali Creek and Kanyin Creek from the west. The critical water level of Ngawun River in Thabaung Township is 5.152 meter (17 feet), and the danger water level is 6.897 meter (22.75 feet) above sea level. According to the highest water level statistics from the year 2004 to 2019, all of the years were above the critical water level. In order to cultivate paddy commercially, the British government had constructed an embankment from Hinthada to Thabaung on the east bank of Ngawun River in (1871-1876). The embankment was 122.109 km (75 miles 7 furlong) long. In the rainy season, when the level of water rises it overflows to the lowlands, and with the fall of the water level, it was mainly drained through Ngawun River, Daga River, Tabu Creek, Htanzinhla Creek, Shwenyaungbin Creek, Udo Creek and Hngetpauk Creek. The overflowed water flowed through Daga River to Kangyidaunt Township, so flooding in Thabaung Township was not very serious. But now embankment have been built along the south of Daga River, which is the main drainage of the region, in order that Kangyidaunt Township can cultivate paddy. As the main drainage has been blocked by the embankments, flooding period within the embankment became longer. Although canalization of the poor drain creeks in the flood plain area leading to the Irrigation and Water Utilization Management Department since 2013-2014, no reduce to the annually prolonged flood.

Keywords: Thabaung Township, Ngawun River, critical water level, embankment, canalization, prolonged flood

Introduction

River flood have been defined as events of such magnitude that the channels cannot accommodate the peak discharge; in other words, a flood is a flow in excess of the channel capacity, and results in inundation of low-lying flat land adjacent to the channel. Another factor is the modification of river catchments by man in deforestation, agriculture, and drainage, urbanization etc., which may considerably alter the probability of floods of a particular size (John Small and Michael Witherick, 1989).

Thabaung Township is not only situated on the delta region but it is also on the Ngawun River (See figure 1 (a) and (b). Ngawun River is a tidal river. High tide and low tide conditions are found along the Ngawun River course. There are three tidal zones along the river course. (1) Just downstream below the point where Ngawun River and its tributary Daga River merge together, a current moves up and down and this area is affected by salt water due to tidal action. (2) From the confluence of Ngawun and Daga Rivers to the south of Thabaung, although there is a current flowing up and down, this part is not affected by salt water. (3) From the north of Thabaung at the upper Ngawun River, although there is no current moving up and down, but changes in velocity is caused by tidal action (Aung Swe, 2007).

Major causes of flooding on the Ngawun riverine area are experienced high tide water level from the Andaman Sea, downstream discharge from the Ayeyarwady River and successive rain during the peak monsoon period in the study area. The factor causing annually prolonged flood in

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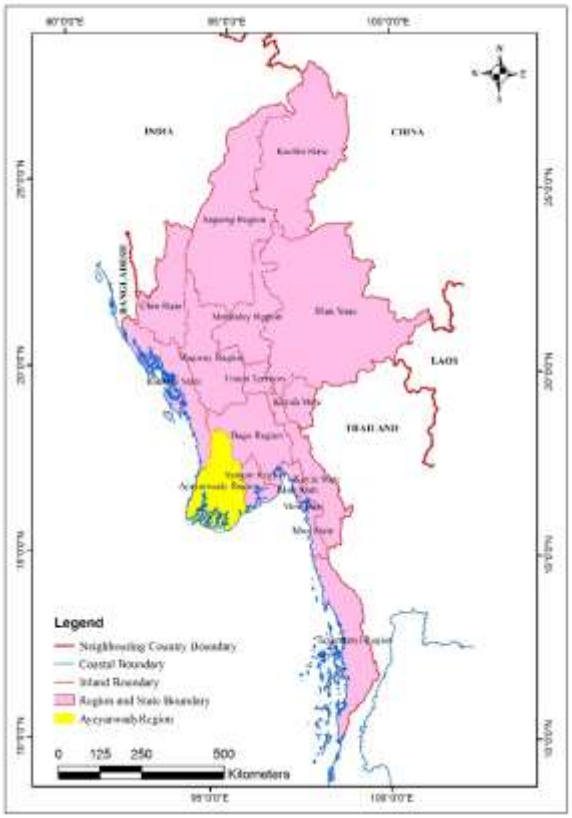
[*] Best Paper Award Winning Paper in Geography (2020)

the study area are included the physical features, weather conditions, the construction of Ngawun and Daga embankments and over exploitation of forest resources in Rakhine mountain ranges in Thabaung Township.

The eastern part of the Thabaung Township is under 5.152 meter (17 feet) above sea level and suffers the consequences of the tidal effect. At the time of high tide, the water level rises and the velocity of the river slows down which causes of the prolonged flood.

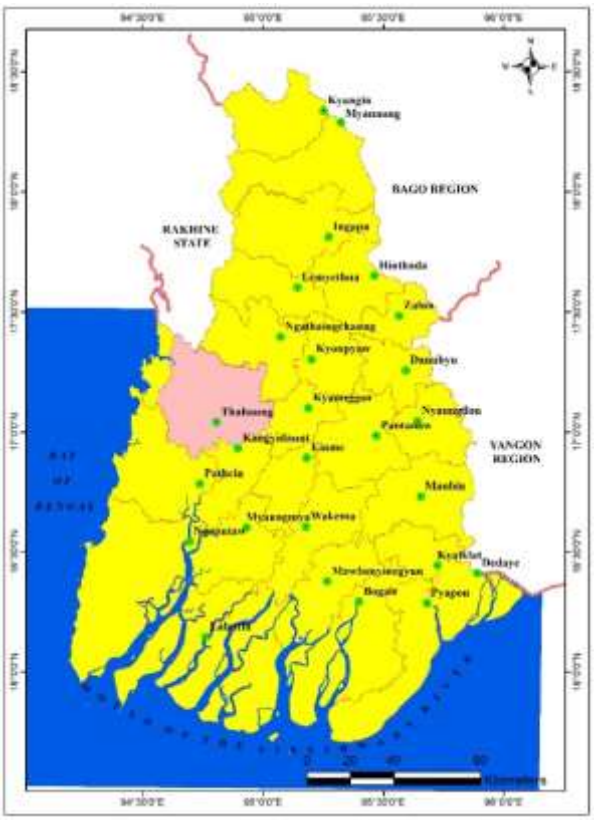
Aim and Objectives

The main aim of this research is to find out the way to reduce annually prolonged flood in the study area. The main objectives are to study major causes of annually prolonged flood, to analyze highest water level condition of Ngawun River in Thabaung Township, to extract flood affected area of the study area, and to assess relationship between the construction of embankment, block of natural water drainage system, canalization, and prolonged flood in the study area.



Source: Myanmar Survey Department, Yangon

Figure1(a) Location of Ayeyarwady Region in Myanmar



Source: Myanmar Survey Department, Yangon

Figure 1(b) Location of Thabaung Township in Ayeyarwady Region

Materials and Methods

UTM topographic maps (1:50000 scale, 2002, Myanmar Survey Department, Yangon) are used to obtain length measurement of Ngawun River. Highest water level data and canalization data are derived from Irrigation and Water Utilization Management Department, Pathein. Elevation class and flood affected area are extracted from the 30 meter resolution DEM (Digital Elevation Model).

Results and Discussion

Major Causes of Annually Prolonged Flood in Thabaung Township

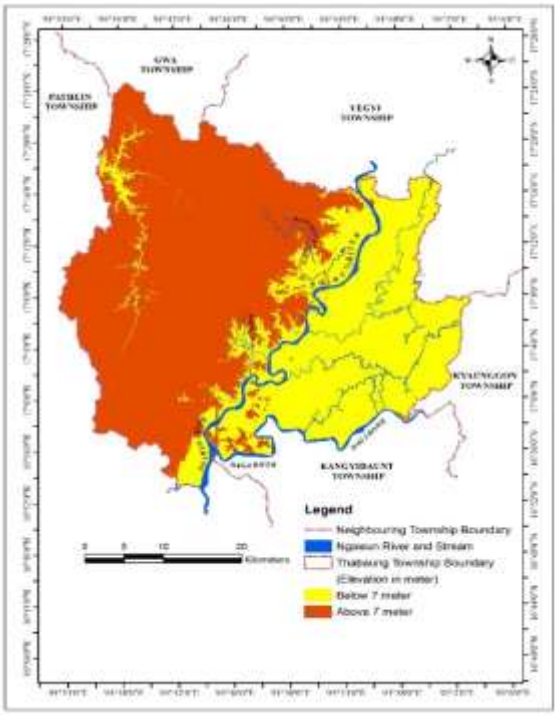
1. Relief and drainage condition

Relief

Except the western part of the township, the remaining area is situated on the deltaic region. Therefore, 58.96% of the township is hilly region and 41.04% is flood plain region.

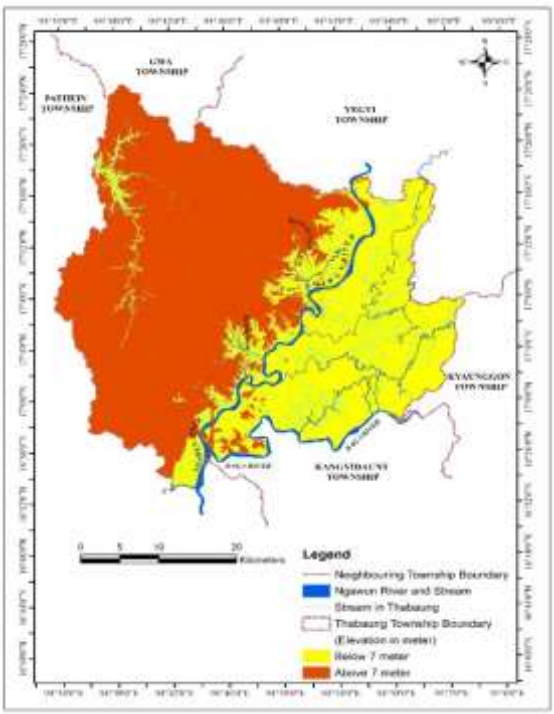
Western hills are situated in the western part of the Thabaung Township which is composed of Rakhine mountain ranges and hills. Most of the hills in this part run from north to south and it is found that the northern part is higher. These hills, slope down eastwards to the Ngawun River. The western hills are composed of the major reserved forest, such as Kyeintali, Sitsayan, Khayu, Kyaukchaunggyi unreserved forest. The western hill region covering 58.96% of the township and being a water reached of the tributaries entering into the Ngawun River, water level rises when there is heavy rain.

The alluvial plain composed of alluvial deposited by Ngawun River and its tributaries is in the eastern side of Thabaung Township and is a very flat plain. Ngawun River passes through meandering alluvial plain with northeast and southwest alignment. Except the very few places, the whole plain is below 7 meters (22.96 feet) above sea level. In the western side of the Ngawun River the alluvial plain gently slopes down from the foothills of the Rakhine mountain ranges to the eastern side. In some areas, spur stretching from the Rakhine mountain ranges form as ridges. In the eastern side of the Ngawun River, the alluvial plain is more flat than that of the western side. It is also the lowest part in Thabaung Township. The extent of the whole alluvial plain is about 41.04%. (Figire 2)



Source: Myanmar Survey Department, Yangon : 30 meter resolution DEM

Figure 2 Relief of Thabaung Township



Source: Myanmar Survey Department, Yangon : 30 meter resolution DEM

Figure 3 Drainage of Thabaung Township

Drainage

Thabaung Township is a part of Ayeyarwady deltaic region. The Ngawun River flows across the Thabaung Township from north to south. The main river is Ngawun. It is the first distributary and divert from the western side of Ayeyarwady River at about 14.48 km (9 miles) above Hinthada, near Nyaunggyo village, Ingapu Township. It flows in a northeast-southeast direction. There are many bends along its course within the township. Ngawun River enters Thabaung Township near Thayetkone Village Tract and flows from northwest to southeast until Setdaunggyi Village Tract. Then it turn to the southwest. From Thinganpinseik Village Tract, the river bends to the west and east repeatedly until Pathein-Thabaung boundary which is near Theaphyu Village Tract. The bending of the river reduces the river velocity enhancing the duration of river flood. As Ngawun River is a yearly flooded one, the deposition of sediments are found along the river banks as natural levees especially in the western bank.

The main tributaries of Ngawun River are Tabu Creek, Shwenyaungbin Creek and Daga River from the east and Kyeintali Creek and Kanyin Creek from the west.

Tabu Creek flows from Yekyi Township and is known as Htanzinhla Creek in Yekyi Township and when it flows through Thabaung Township, it is known as Tabu Creek. Flowing from northeast to southwest, it turns to the west in Thayettaw Village Tract and flows into the Ngawun River near Dekone Village Tract. There are many small creeks flowing into Tabu Creek.

Shwenyaungbin Creek is also one of the creeks flowing into the Ngawun River from the east. It enters Thabaung Township from Kyaunggone Township and passes through the eastern alluvial plain and joins the Ngawun River near Shwenyaungbin Village Tract. Udo Creek is connected with Daga River and Shwenyaungbin Creek.

Daga River is the largest tributary and it is flowing into the Ngawun River within Thabaung Township. It starts in Kyaunggon Township and then flows to the west as the boundary between Thabaung and Kangyidaunt townships. It enters Ngawun River near Kintat Village Tract.

The tributaries of Ngawun River in the eastern side are connected with each other by small streams like a network. This is one of the characteristics of deltaic region and is one of the reason causing the most serious flood especially in the eastern side of the Ngawun River.

Kyeintali Creek takes it source from the Rakhine Mountain Range in the northernmost part of the township. From it source, it flows in a northwest and southeast direction into the Ngawun River from the west near Hpayakone Village Tract.

Kanyin Creek also takes it source from Rakhine Mountain Range in the west of Thabaung Township. It flows from north to south and turns to the southeast and flows into the Ngawun River near Thabaung Township.

The tributaries of Ngawun River from the west which take their source from the Rakhine Mountain Range can carry much sediments into the Ngawun River. Ngawun River and all its tributaries within Thabaung Township are tidal in nature. (Figure 3)

2. Channel pattern of Ngawun River in Thabaung Township

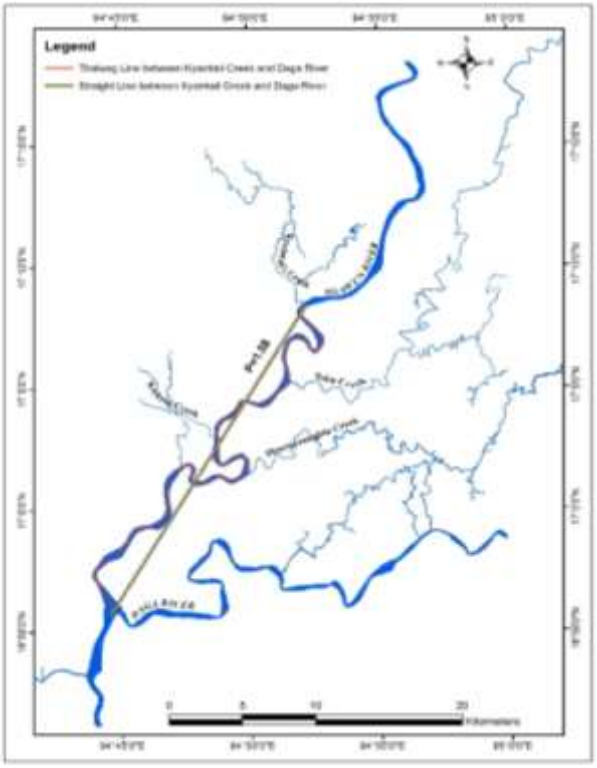
Channel pattern is related to the sinuosity ratio. The ratio between the measured length of a stream channel and that of the thalweg of its valley is measured by its sinuosity. Sinuosity ratio P is 1.0 for straight channel, 1.2 for transitional between straight and regular, 1.5 for regular channel, 1.7 for irregular channel and 2.1 for tortuous (Chorley, R.J., 1984).

In this paper sinuosity ratio is calculated based on the confluence of Ngawun River and its tributaries. There are five main tributaries entering into the Ngawun River from western and eastern

banks. Kyeintali Creek and Kanyin Creek from the west and Tabu Creek, Shwenyaungbin Creek, and Daga River from the east. Between the confluence of Ngawun River-Kyeintali Creek and Ngawun River-Daga River, thalweg line length of Ngawun River is 42.94 km and straight line length is 27.16 km respectively. Therefore, sinuosity ratio is 1.58 and channel pattern is nearly irregular channel. (Figure 4)

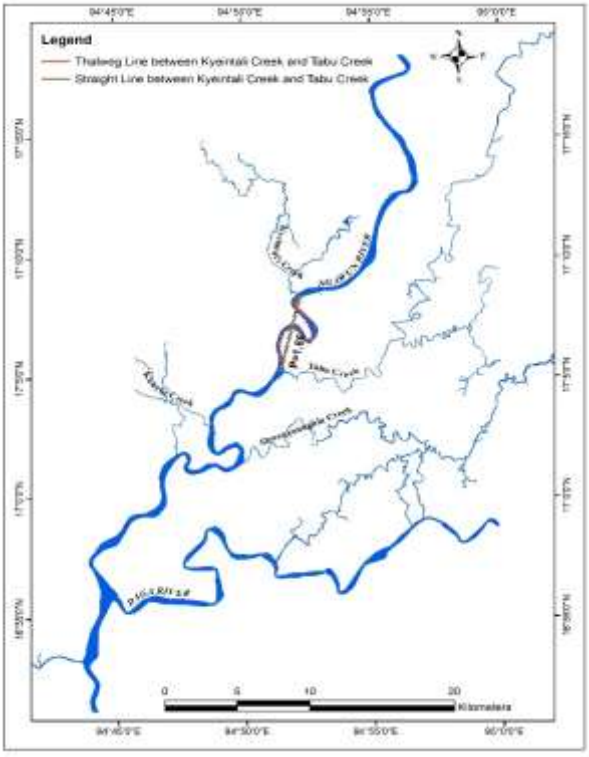
For more detail study, between the confluence of Ngawun River-Kyeintali Creek and Ngawun River-Daga River segment is subdivided into four segments from north to south, namely such as between the confluence of Ngawun River-Kyeintali Creek and Ngawun River-Tabu Creek, between the confluence of Ngawun River-Tabu Creek and Ngawun River-Kanyin Creek, between the confluence of Ngawun River-Kanyin Creek and Ngawun River-Shwenyaungbin Creek, and between the confluence of Ngawun River-Shwenyaungbin Creek and Ngawun River-Daga River.

Straight line length and thalweg line length between the confluence of Ngawun River-Kyeintali Creek and Ngawun River-Tabu Creek are 5.94 km and 9.88 km respectively. Therefore sinuosity ratio is 1.66 and channel pattern is nearly irregular. In this portion, Ngawun River is likely to be meandering channel as shown in figure 5.



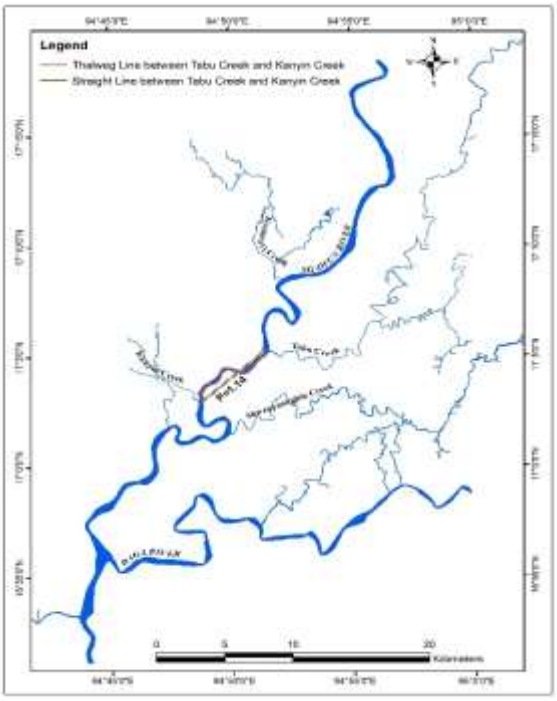
Source: Myanmar Survey Department, Yangon (2002)

Figure 4 Channel pattern between the confluence of Ngawun River-Kyeintali Creek and Ngawun River-Daga River



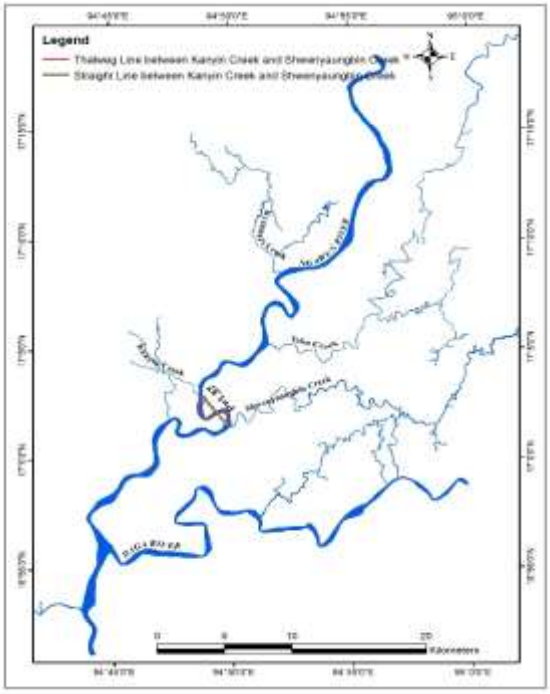
Source: Myanmar Survey Department, Yangon (2002)

Figure 5 Channel pattern between the confluence of Ngawun River-Kyeintali Creek and Ngawun River-Tabu Creek



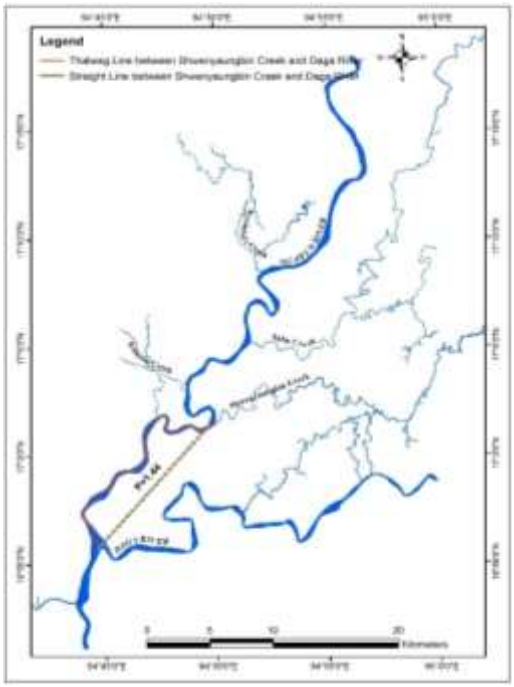
Source: Myanmar Survey Department, Yangon (2002)

Figure 6 Channel pattern between the confluence of Ngawun River-Tabu Creek and Ngawun River-Kanyin Creek



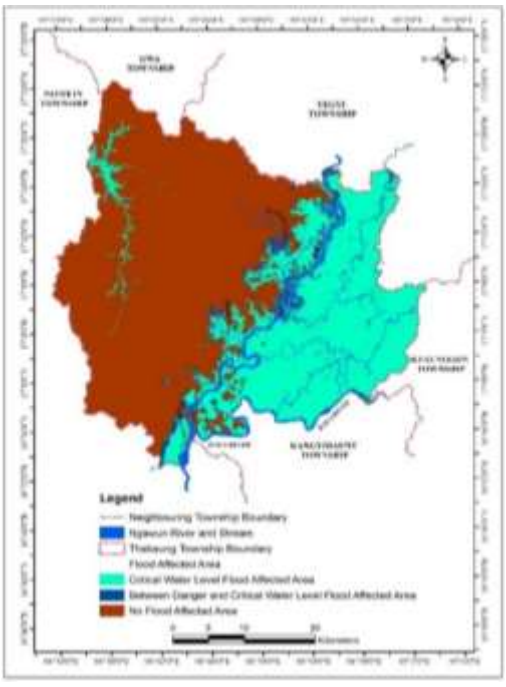
Source: Myanmar Survey Department, Yangon (2002)

Figure 7 Channel pattern between the confluence of Ngawun River-Kanyin Creek and Ngawun River-Shwenyaungbin Creek



Source: Myanmar Survey Department, Yangon (2002)

Figure 8 Channel pattern between the confluence of Ngawun River-Shwenyaungbin Creek and Ngawun



Source: Myanmar Survey Department,Yangon
: 30 meter resolution DEM

Figure 9 Flood affected area of Thabaung Township

Straight line length and thalweg line length between the confluence of Ngawun River-Tabu Creek and Ngawun River-Kanyin Creek are 6.42 km and 7.36 km respectively. Therefore, sinuosity ratio is 1.14 and channel pattern is nearly transitional between straight and regular as shown in figure 6. Between the confluence of Ngawun River-Kanyin Creek and Ngawun River-Shwenyaungbin Creek, length of straight line and thalweg line are 3.19 km and 5.03 km respectively. Therefore, sinuosity ratio is 1.57 and channel pattern is regular as shown in figure 7. Between the confluence of Ngawun River-Shwenyaungbin Creek and Ngawun River-Daga River, length of straight line and thalweg line are 14.31 km and 20.67 km respectively. Therefore, sinuosity ratio is 1.44 and channel pattern is also regular. (Figure 8)

3. Water level condition of Ngawun River in Thabaung Township

According to the Thabaung Township Irrigation Department's norm, the critical water level of Ngawun River in Thabaung Township is 5.152 meter (17 feet), and the danger water level is 6.897 meter (22.75 feet) above sea level. The annual highest water level of Thabaung Township collected from Zeepinkwin gauging station for the period from 2004 to 2019 is given in table 1. According to the highest water level statistics, all of the years were above the critical water level.

4. Simulation of flood affected area based on critical and danger water level employing the surface model

Calculation of flood affected area is based on the critical and danger water level of the Zeepinkwin gauging station in Thabaung Township. Flood affected area under critical water level (5.152 meter) of Thabaung Township is about 674.22 square kilometer (37%) of the total and flood affected area under danger water level (6.897 meter) of Thabaung Township is about 744.19 square kilometer (40.88%) of the total as shown in figure 9.

Table 1 Highest water level of Zeepinkwin gauging station, Thabaung Township

Year	Highest Water Level		Year	Highest Water Level	
	Meter	Feet		Meter	Feet
2004	6.93	22.75	2012	6.4	21
2005	5.64	18.5	2013	6.17	20.25
2006	5.67	18.6	2014	5.84	19.15
2007	6.71	22	2015	6.78	22.25
2008	6.19	20.3	2016	6.83	22.4
2009	5.78	18.95	2017	6.49	21.3
2010	5.61	18.4	2018	5.79	19
2011	6	19.7	2019	5.67	18.6

Source: Irrigation and Water Utilization Management Department, Pathein

5. Construction of Embankment along the Ngawun River and Daga River

Ngawun River is the first river that branched off from the Ayeyarwady on the right side. It is the most important of the distributaries of the Ayeyarwady, and at that time there is heavy rainfall in the Deltaic region and streams and rivulets from the mountain and uplands bring down large volume of water into Ngawun River. In the southern part of the Ngawun River tidal effect is also

experienced. So the delta region of Myanmar has very good alluvial soil which are very suitable for paddy cultivation. In order to cultivate paddy commercially, the British government had constructed an embankment from Hinthada to Thabaung on the east bank of Ngawun River in (1871-1876). The embankment was 122.109 km (75 miles 7 furlong) long (ဦးအုန်းမြင့်၊ ၁၉၇၆).

The embankment was constructed on the eastern part of Ngawun River because the cultivated acreage of paddy is greater on the east than on the west side, and the deltaic characteristic are more pronounced. Due to the protection of the embankment, the east side of Ngawun River is quite free from danger of flooding. But as there are no embankment in the west side, it is liable to annual flooding and sometimes even the east side experiences flooding. There are no embankment on the west side in order to avoid double embankment system. If both side of the river have embankment, the flow volume of the river will be very strong. The embankment will not be able to retain such great volume of water for long, and sooner or later, there will be breaches which will cause sudden flooding. So embankments are constructed only on the east side of the river where the cultivable acreages are greater and the west side are left as a flooded area.

During the British period in order to promote paddy cultivation, Ngawun embankment was constructed starting from Hinthada passing through Laymyethna and Ngathainggyaung to the north of Tabu Creek in Thabaung Township. If the embankment was continued southwards, the volume of water brought down from the upper course in the rainy season was very great, the great volume of water brought down from the mountain streams of the west, the rise of tide from the south that reached Thabaung, all these factor would cause great flood especially to Pathein, Kangyidaunt and Kyaunggon townships. Moreover, rail road and motor roads would be flooded and suffered damage. So the embankment was not continued southwards but ended at Tabu Creek. By construction this embankment, the water that flowed from the Ngawun River in the rainy season was diverted to the eastern lowlands Thabaung, acting as a break for the water flow. Although there was flooding, the water rose gradually, which was not harmful to either roads or motor roads.

In the rainy season, when the level of water rises it overflows to the lowlands, and with the fall of the water level, it was mainly drained through Ngawun River, Daga River, Tabu Creek, Htanzinhla Creek, Shwenyaungbin Creek, Udo Creek and Hngetpauk Creek.

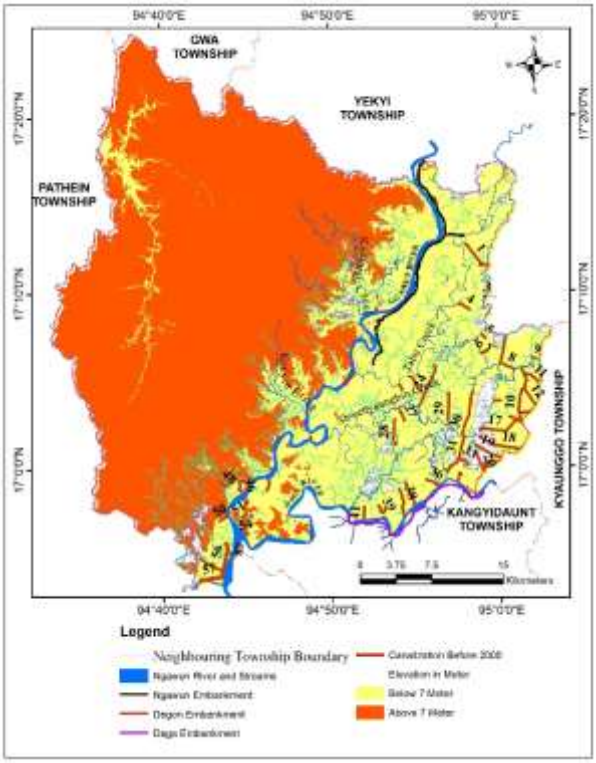
The overflowed water flowed through Daga River to Kangyidaunt Township, so flooding in Thabaung Township was not very serious. But now embankment have been built along the south of Daga River, which is the main drainage of the region, in order that Kangyidaunt Township can cultivate paddy. As the main drainage has been blocked by the embankments, flooding period within the embankments became longer, especially in Thabaung and Yegyi townships. With the construction of a new embankment in the southern side of Tabu Creek from Magyigone to Daegon Village in Thabaung Township, villages in the lower section are more in danger of flooding. Although there is an embankment on the east side of Ngawun River, the area between the embankments and the river experience flooding every year.

Irrigation and Water Utilization Management Department constructed 46 new canal and canalization in the flood plain area with the length of 112.08 km since before year 2000, 128 new canal and canalization in the flood plain area with the length of 425.59 km between 2013-2018, 26 new canal and canalization with the length of 87.88 km in 2019, and 13 new canal and canalization with the length of 53.61 km in 2020 respectively. Total length of the stream in flood plain area of Thabaung Township is about 1324 km and length of constructed new canal and canalization is about 679.16 km. Therefore, percentage of the length of constructed new canal and canalization is about 51% of the total stream length of the flood plain area as shown in table 2, 3, 4, 5 and figure 10, 11, 12, 13, 14.

Table 2 Site of canalization in Thabaung Township (before 2000)

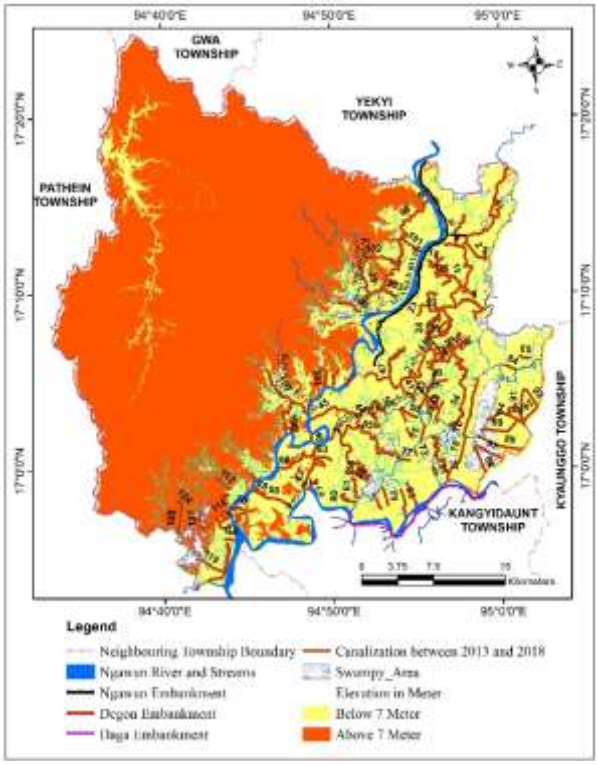
No.	Length (km)	No.	Length (km)	No.	Length (km)	No.	Length (km)
1	2.94	16	0.06	31	4.51	47	0.65
2	1.18	17	4.63	32	0.30	48	1.19
3	0.37	18	4.75	33	1.35	49	1.18
4	1.55	19	3.19	34	1.12	50	1.06
5	0.78	20	2.31	35	0.33	51	0.84
6	1.05	21	1.52	36	1.64	52	0.51
7	3.11	22	0.44	37	2.78	53	0.44
8	1.40	23	1.83	38	3.24	54	0.59
9	0.40	24	4.94	39	1.23	55	0.23
10	6.08	25	2.23	40	0.84	56	1.61
11	1.84	26	0.80	41	1.50	57	4.42
12	2.19	27	1.50	42	0.44	58	1.66
13	1.23	28	2.91	43	0.38	59	2.06
14	0.86	29	3.33	44	1.42	60	2.63
15	1.54	30	4.89	45	1.05	61	0.45
				46	1.82	62	2.76

Source: Irrigation and Water Utilization Management Department, Pathein



Source : Myanmar Survey Department, Yangon
: 30 meter resolution DEM
: Irrigation and Water Utilization Management Department, Pathein

Figure 10 Canalization in Thabaung Township (before 2000)



Source : Myanmar Survey Department, Yangon
: 30 meter resolution DEM
: Irrigation and Water Utilization Management Department, Pathein

Figure 11 Canalization in Thabaung Township (between 2013 and 2018)

Table 3 Site of canalization in Thabaung Township (between 2013 and 2018)

No.	Site of Canalization	Length (km)	No.	Site of Canalization	Length (km)
1	Ngabat Creek (Akeyo)	1.96	33	No.23 canal (Htanzinhla, Kyaye, Magyigone)	7.49
2	Kyibinyo Creek	1.97	34	No.22 Lahata Creek (Htangyogone, Kyaye)	18.42
3	Aleyo Creek	2.38	35	Yayosin	0.59
4	Akegyi Creek	2.07	36	Byetkawgyi Creek	0.62
5	Thantada Creek	1.14	37	Umaungdaing Creek (Magyigone)	2.61
6	Kywebyu Creek	3.15	38	Kanyingone Canal (Magyigone)	0.38
7	Kanyin Creek	1.11	39	Kyaye Creek	3.69
8	Chinphaya Creek	4.20	40	Kwinlezu Creek	2.00
9	Sakhangyi Creek	2.14	41	Utinnyunt Creek	2.84
10	Akegyi Creek (1)	1.63	42	Kadetyo Creek (Kanyingon)	3.11
11	Akegyi Creek (2)	1.96	43	Cross Kanyingon Canal	1.50
12	Akegyi Creek (3)	1.70	44	Shingyibyauk Canal	2.83
13	Akegyi Creek (4)	0.93	45	Pyidawthar Canal (Thayetgon, Sison)	3.64
14	Akegyi Creek (5)	1.04	46	Yonchaung (Kanyinbin)	0.77
15	Akegyi Creek (6)	1.97	47	Lahabaing Creek (Pyidawthar, Thayettaw)	6.61
16	Akegyi Creek (7)	0.26	48	Ward No. 3 Canal	0.71
17	Denanyo Creek	1.43	49	Shwenyaungbin Creek	2.53
18	Dawpantinyo Creek	1.42	50	Lindagya Canal	2.99
19	Nyaunggone Creek	0.81	51	Mithwedaik Canal	6.70
20	Akegyi Creek (8)	1.60	52	Hlayswae Canal	4.76
21	Innmagyi	1.23	53	Alegyun (Yegyo)	2.14
22	Ledi Creek	4.33	54	Yedwingon Canal	1.59
23	Migyaunggaung Creek	1.92	55	Ngamangyaung-Ngamyetsanni Creek	8.63
24	Hlayswae Creek	1.54	56	Nwenikyaung Creek	7.65
25	Shwesan Creek	0.21	57	Kywelan Creek	1.14
26	Hninsan Creek	0.12	58	Bwettaw Creek	3.36
27	Htanzinhla Creek	0.60	59	Thidatkalay Creek (Shwenyaungbin)	2.41
28	Htantabin (Pyinmagauk)	6.50	60	Ngu Creek (Daga-Nyaunggon)	2.96
29	Kyaikpi (Htanzinhla)	4.99	61	Khwethe Creek (Daga-Nyaunggon)	3.10
30	Laychaung Creek	2.46	62	Thayetkon-Satthwa Creek	5.28
31	Thayetchaung Creek	1.49	63	Shwenyaungbin-Kywelanyo Creek	2.08
32	Hngetchaung Creek	2.14	64	Thamingon-Kywelan Creek	1.57

Source: Irrigation and Water Utilization Management Department, Pathein

Table 3 Site of canalization in Thabaung Township (between 2013and 2018) continued

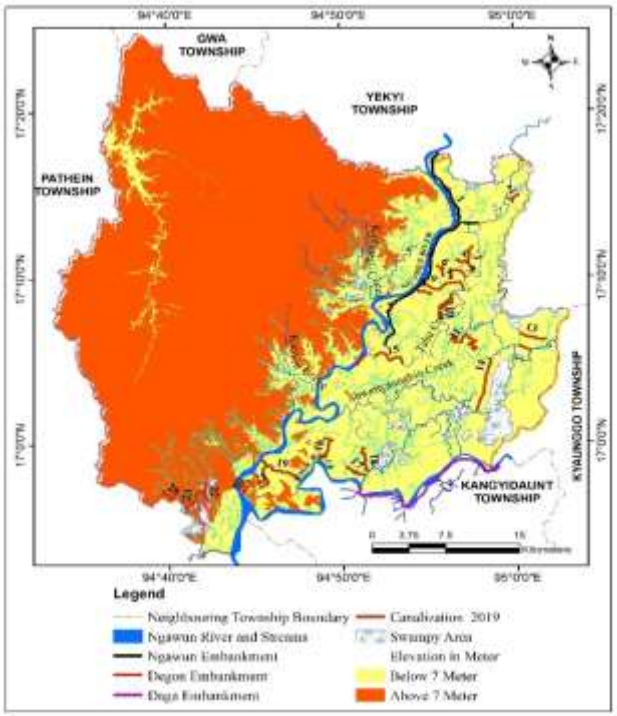
No.	Site of Canalization	Length (km)	No.	Site of Canalization	Length (km)
65	Kyauksayitkon Canal	1.11	97	Thayetkon-Paukhlut	0.59
66	Khathtiya-Nyaunggonlay Canal	5.34	98	Sinchaung	20.01
67	Pauktan Canal	1.87	99	Lahargamon-Myayniaing	7.21
68	Ngawun-Dauntgyi Canal	5.66	100	Udo	3.67
69	Peinnechaung Canal	1.58	101	Kyaynan-Maunghnamagon-Wunloke	3.41
70	Taungthayetkon (Kindat)	1.28	102	Kwaygok	5.35
71	Ngugyaung (Kindat)	2.13	103	Kalarhpan	2.56
72	Layeindan Canal	1.31	104	Pazundaung	2.52
73	Leingon Canal	0.83	105	Kyigangyun	0.94
74	Okshit (Htado Canal)	1.35	106	Wayachaung	3.50
75	Gonnyindan Canal	1.99	107	Kanyin Chaung	8.42
76	No.9 Canal (Kyaye-Mandaing)	6.34	108	Myaukngu Chaung (Gayatkyi Chaung)	4.73
77	Panbinseik Creek	8.97	109	Hpauk Chaung	0.69
78	No. 7 Canal	4.51	110	Nannanbingon	3.48
79	Tagundaing Canal	2.08	111	Kungyungon	1.14
80	Kalawe Canal	2.15	112	Obo	2.61
81	Gyongyongya Canal (Sinlan)	1.13	113	Kyauksalikkon	1.68
82	No.38 Canal	2.77	114	Kunthigyan	1.16
83	No.39 Canal (Mewin Canal)	3.25	115	Ayeyarwady	1.97
84	Volunteer Canal (Sitpingyi)	1.40	116	Zibyugwin	2.08
85	Kyudawyo Canal	1.33	117	Kangon	0.90
86	Byaikgyi Canal (Phayani)	3.12	118	Htanbingyaung	1.26
87	Gomin Canal No.1	3.19	119	Aungdat	3.28
88	Ohnpinzu Canal No.2	5.03	120	Aungdat	3.08
89	Gomin Canal No.12	4.62	121	Aungdat	3.16
90	Gonmin-Natsin-Dedok Canal	5.57	122	Thebyu	2.09
91	Gomin Canal No.13	3.81	123	Ngakywetkon	3.74
92	Gomin Canal No.14	2.31	124	Pwegyaw	1.71
93	Gomin Canal No.15	2.23	125	Kyaukaing	3.23
94	Pauktaw Canal	2.25	126	Kyungon	2.40
95	Tabu Chaung	45.98	127	Kanyinmyaung	3.64
96	Ngabat Creek-Shauk Creek	1.08	128	Hpongyi Chaung	2.72

Source: Irrigation and Water Utilization Management Department, Pathein

Table 4 Site of canalization in Thabaung Township (2019)

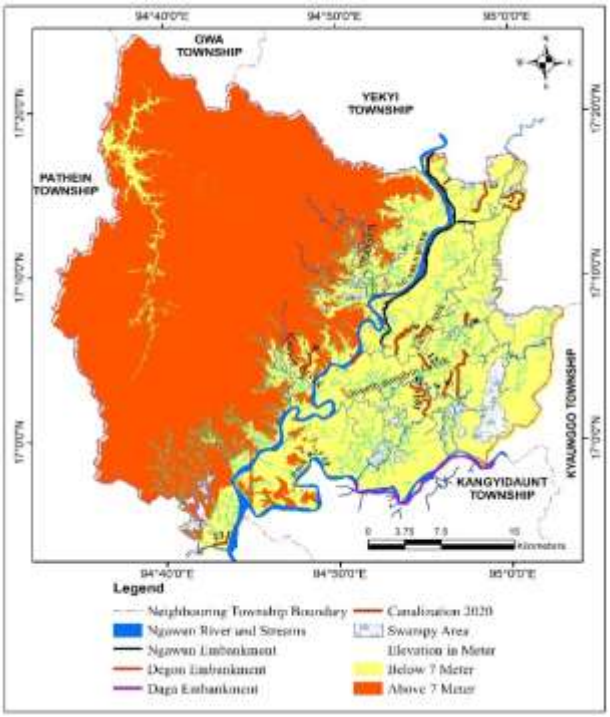
No.	Site of Canalization	Length (km)	No.	Site of Canalization	Length (km)
1	Ngawun Embankment 64/4-67 mile	4.30	14	Number (9) Canal	6.27
2	Upper Akegyi Number (8) Canal	2.01	15	Tabu Chaung Canal	4.11
3	Upper Akegyi Number (7) Canal	2.33	16	Kyauksayitkon Kywelan Canal	4.28
4	Upper Akegyi Number (1) Canal	2.87	17	Ngu Chaung	3.00
5	Upper Akegyi Number (2) Canal	3.44	18	Khwethe Chaung	3.73
6	Upper Akegyi Number (4) Canal	2.35	19	Ngawun Dauntgyi-Shwedaungkyun Canal	5.51
7	Upper Akegyi Number (3) Canal	3.60	20	Kindat-Ngu Chaung	3.92
8	Upper Akegyi Number (5) Canal	1.77	21	Kindat-Daunggyi Canal	3.44
9	Upper Akegyi Number (6) Canal	1.64	22	Letkok Chaung	2.33
10	From Pyinmagauk to Htanbingyi Canal	6.44	23	Yekyi Chaung	4.24
11	Number (22) Canal	7.15	24	Nyaung Chaung	0.87
12	Sitpingyi Canal	1.41	25	Umoe Chaung	0.92
13	Kyidawyo Canal	2.94	26	Kayu Chaung	3.03

Source: Irrigation and Water Utilization Management Department, Pathein



Source : Myanmar Survey Department, Yangon
: 30 meter resolution DEM
: Irrigation and Water Utilization Management Department, Pathein

Figure 12 Canalization in Thabaung Township (2019)



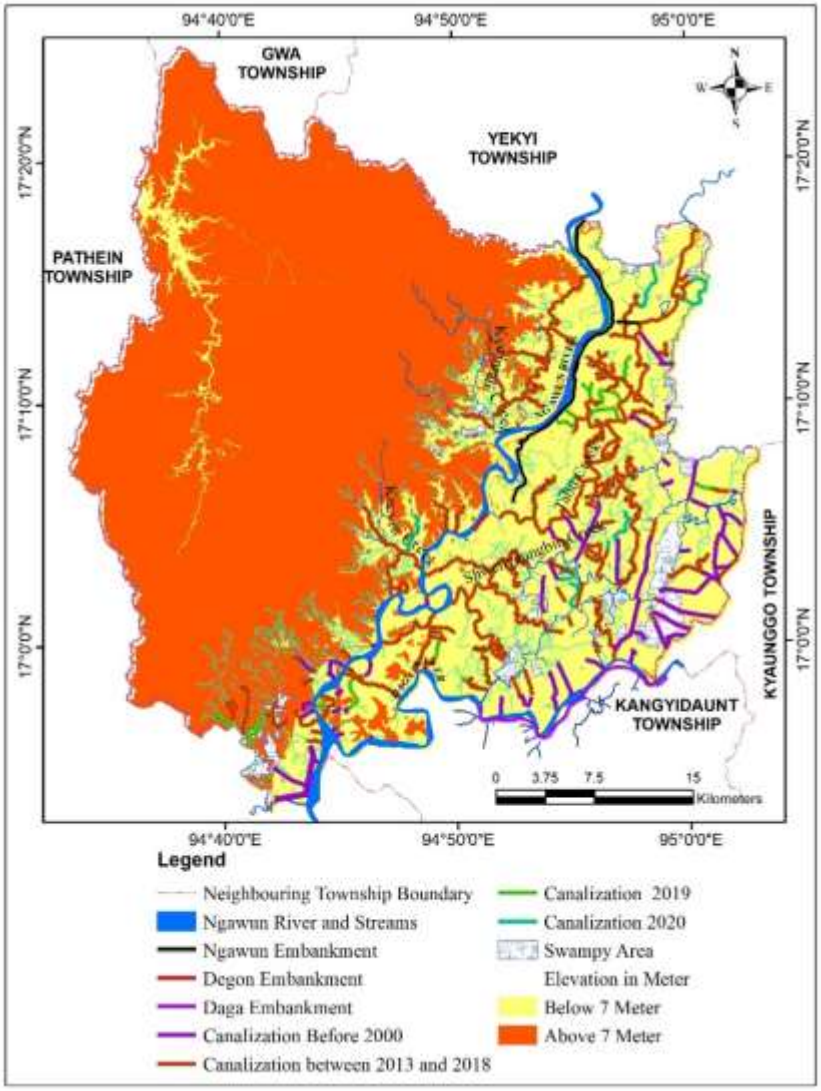
Source : Myanmar Survey Department, Yangon
: 30 meter resolution DEM
: Irrigation and Water Utilization Management Department, Pathein

Figure 13 Canalization in Thabaung Township (2020)

Table 5 Site of canalization in Thabaung Township (2020)

No.	Site of Canalization	Length (km)	No.	Site of Canalization	Length (km)
1	Ngawun Embankment	4.67	7	Pyidawthar Chaung	6.51
2	Mayangon Creek-Shaukchaung Creek	6.28	8	Hngetyo Chaung	2.48
3	Ake Creek	4.27	9	Mayin Chaung	4.07
4	Kyaye-Kadatyu Canal	3.34	10	Kwinya Canal	3.20
5	Lahata Canal (Number 22)	6.69	11	Popon Chaung	4.23
6	Yon Chaung	2.87	12	Umaungdaing Chaung	2.23
			13	Thaephyu	2.76

Source: Irrigation and Water Utilization Management Department, Pathein



Source : Myanmar Survey Department, Yangon
: 30 meter resolution DEM
: Irrigation and Water Utilization Management Department, Pathein

Figure 14 Canalization in prolonged flood area

Although construction of new canals and canalization of the poor drain creeks in the flood plain area lead by the Irrigation and Water Utilization Management Department since 2013-2014 are found no reduction of the annual prolonged flood is seen.

Conclusion

The factor causing prolonged flood in the study area are due to the physical features (relief, drainage), channel pattern, water level condition of Ngawun River, the construction of embankments, poor drainage condition of the flood plain area and unsystematic canalization. In the rainy season, when the level of water rises it overflows to the lowlands, and with the fall of the water level, it was mainly drained through Ngawun River, Daga River, Tabu Creek, Htanzinhla Creek, Shwenyaungbin Creek, Udo Creek and Hngetpauk Creek. But now embankment have been built along the south of Daga River. As the main drainage has been blocked by the embankments, flooding period within the embankments became prolong. Moreover, monsoon paddy cultivation of the flood plain area is gradually decreasing and harmful to the local people's socio-economic development. Local authority urgently perform river training of Ngawun River and systematic canalization of small streams and creeks over prolonged flood area.

Acknowledgements

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ဦးအုန်းမြင့်၊ (၁၉၇၆) ဧရာဝတီမြစ်ဝကျွန်းပေါ်အတွင်းရေကြီးမှုအစီရင်ခံစာ (ပ+ဒု)၊ ဆည်မြောင်းဦးစီးဌာန၊ လယ်ယာနှင့် သစ်တော ဝန်ကြီးဌာန။

ANTHROPOGENIC PRESSURE ON URBAN DEVELOPMENT AND LAND USE CHANGE OF KYAUKPHYU TOWN, RAKHINE STATE

Ohnmar Myat Htoo[1] Kathi Soe[2]

Abstract

This paper presents the geographical analysis on urban development and land use changes of Kyaukphyu caused by human pressure. Kyaukphyu, a medium-size township located on Yambye Island, is less favourable for urban growth. But some rural areas closed to the town are upgraded to town. Therefore, rural population is shifted within kyaukphyu town and rural dweller area is displaced by some economic activity. Although most of the residential land use of the town area changed to commercial land use, some residential areas changed to unused land due to effect of human pressure. The main objectives are to study the land use changes by urban growth and to examine the future economic activities of Kyaukphyu Township. To analyze the urban growth and land use changes in the urban area of Kyaukphyu in 1958, 1996 and 2019, remote sensing technique and ArcMap GIS 10.3.1 software are used.

Keywords: Urban growth, land use changes, economic condition, Kyaukphyu Township

Introduction

Urbanization is a process whereby populations move from rural to urban area, enabling cities and towns to grow. It is highly influenced by the notion that cities and towns have achieved better economic, political, and social mileages compared to the rural areas (Pawan, 2016).

The growth and the shape of Kyaukphyu Town are largely controlled by the existing physical features, particularly by relief and drainage. As it is bounded north, east and south by the Kyaukphyu and Ngalapway rivers, the extension of town area to these directions is hardly possible. However, there is a wide space of land between the southernmost settlement area and Ngalapway River. Thus, the spillover from the inner urban area and those who migrated from the rural area were mostly pulled towards the southwestern margin. The economic factor and accessibility have had greater effect over the placement of human settlement.

Population is also a critical factor in determining the rate of urban growth as well as economic development of an area. The number or the proportion of urban population which reflects the land use change and the stage of urbanization is interdependent with economic growth of an area.

This study bases on the three maps drawn in 1958, 1996 and 2019. The interval of the time periods is not equal, but these periods are chosen because of drastic changes in the town area and land use change as well as the availability recorded data of the town.

Study area

Kyaukphyu Township is situated in the western extreme of Myanmar. It occupies northern half of Yambye Island in the North Bay of Bengal. It has an area of 1757 square kilometers, comprising 52 villages and 17 wards in the town areas.

Kyaukphyu Township is composed of mountains, hills, low and level land, tidal marshes and streams. The elevation of lowland area is below 5 meters, and town area stands on the flat lowland of less than 5 metres above sea level.

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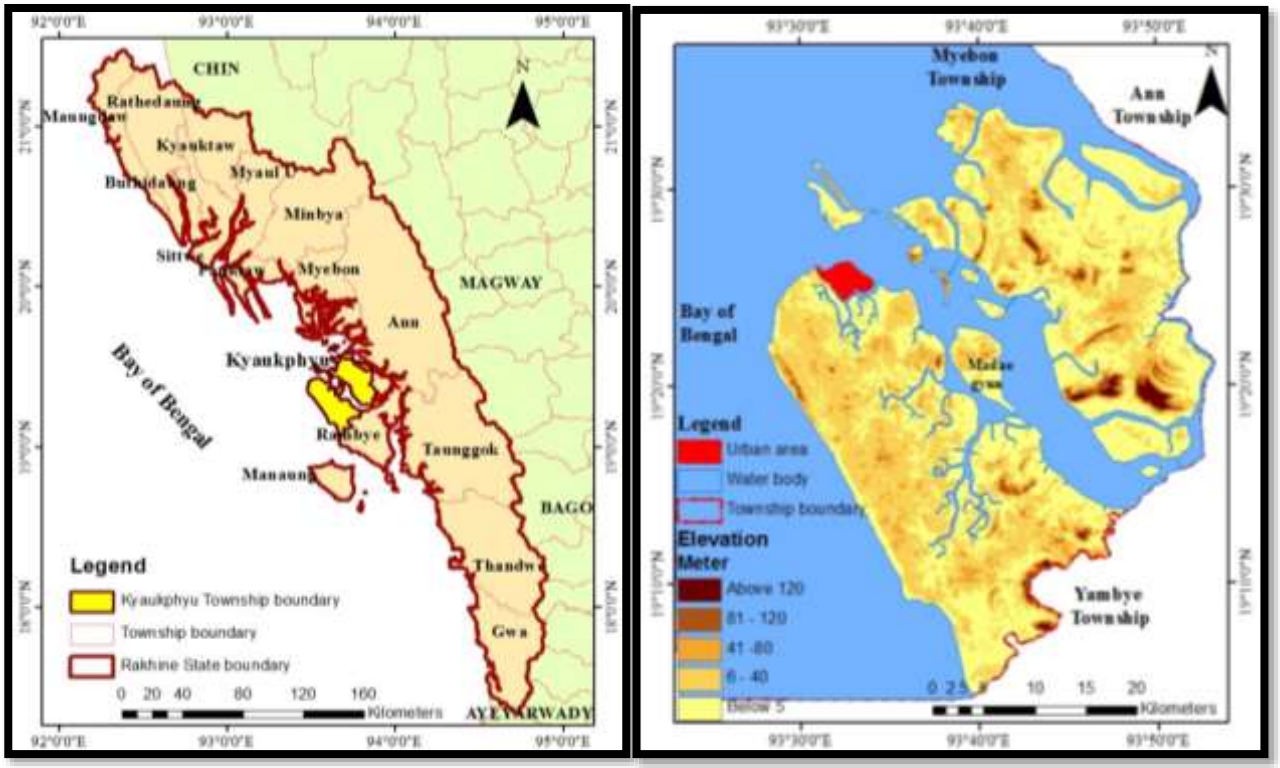


(a) **(b)**

Source: Department of Agricultural Land Management and Statistic (Kyaukphyu), based on DEM

Figure 1(a and b) Location of Kyaukphyu Township in Rakhine State

The town area is latitudinally located between 19˚ 24′ North and 19˚ 26′ North and longitudinally between 93˚ 30′ East and 93˚ 34′ East. It occupies an area of 10.19 square kilometers representing 0.6 percent of the township area. The town comprises 17 wards. Kyaukphyu River locally known as Madekyun River near the Made Island flows towards the northeastern coast of Yambye Island.

According to the recent geological investigation, the Kyaukphyu Township area is covered with Miocene rock unit namely Leikkamaw Formation which is mainly composed of sandstone. They are massive thick bedded sandstones, inter-bedded with thin sandy shale layers. Therefore, Kyaukphyu area is a favourable region for urban development and construction works due to its high resistance of sandstone.

The mean annual temperature of Kyaukphyu Township is 25.3˚ C. The normal annual rainfall of Kyaukphyu Township is 4579.6 mm. According to Koppen's climate classification the township experiences tropical monsoon climate (Am). It is suitable for settlement.

Materials and Methods

In order to get the township, wards, and village tract's boundaries, the study area is digitized based on Aerial photo (No. 113 and 114, scale 1:6000, date 14.2.58), UTM (2000) and Google Earth Images and elevation data are obtained from Digital Elevation Model (DEM).

Land use map is acquired from Agricultural Land Management and Statistics Department and climate data are acquired from the Department of Meteorology and Hydrology, Kyaukphyu.

The information data of urban changes are acquired through random interviews and discussion with local people and population data from Department of Labours, Immigration and Population, Kyaukphyu.

To examine the land use data, Landsat 8 image is also analyzed by using Remote Sensing and ArcMap GIS 10.3.1 software.

Research questions

How do urban area changes in Kyaukphyu?

Which factors affect the land use changes in Kyaukphyu?

Aim

The main aim of the research paper is to assess the relationship between land use changes, urban growth and trend of economic activity in Kyaukphyu Township.

Objectives

The main objectives of the paper are

- To study the growth of urban background factors of Kyaukphyu
- To analyze the factors affecting the land use changes in Kyaukphyu
- To assess the trend of urbanization and economic conditions of Kyaukphyu

Finding

Anthropogenic Pressure On Urban Growth

Historical background of the study area

There had been no permanent group settlement over the present town area prior to A.D 18th century, although few, sporadic dispersed settlement based on fishing activity might have settled in some limited space. According to available evidence, the present Ceditaung Ward was under water by that time and it served as habour of fishing boats.

In B.E (Burmese Era) 793 (A.D 1431), King Saw Mon Gyi of Konbaung dynasty sent Ananda Thuriya, the minister and Myin Si Par, the adviser to Yambye, Thandwe and Manaung to establish a village at the site of the present Seebokekay Village. Large quartz boulders existing beyond the village were so prominent that, the newly formed village was named Kyaukphyu Village.

After the British annexation of the Rakhine area, the scenic view of the Kyaukphyu coast, where a small group of the British settled, was able to attract some new settlers and thus it become a British East India Company's Village.

In 1837, the British government established Kyaukphyu town beyond the village where the land is higher. Kyaukphyu together with Yambye and Myanmaung was put under the control of district office located at Yambye. At that time Ann was also a centre of district administration. However, the district office was shifted to Kyaukphyu in 1845, as the physical environment of Ann was susceptible to fatal diseases. Again in 1852, Kyaukphyu and Yambye were integrated as an only district of the area with office in Kyaukphyu. The actual demarcation of Kyaukphyu Township was made in 1885 and a municipal body to govern the town was also formed. The main present town's plan was initiated by Sir Arthur Vontable in 1905-06.

Population growth

According to the records available, there were 14447 persons within Kyaukphyu Town in 1958, with an urban area of 3.043 square kilometre (304 hectares). Thus, population density was 4748 persons per square kilometre. Although the town area remained unchanged, the population increased to 17899 people in 1973, representing a density of 5882 persons per square kilometer. The average annual growth rate of urban population was 1.0 percent for the 1958 – 1973 periods. As there was no extension in the town area, the residential buildings became more concentrated, thereby reducing open space between buildings.

By the year 1996, the total population rose to 23192 persons. Likewise, the town area has also grown to 3.53 square kilometres (353 hectares), representing a density of 6570 persons per square kilometer. The average annual growth rate was 1.3 percent for the 1973 – 1996 periods.

With the increasing population, the residential buildings gradually emerged, mostly on the open spaces of urban fringe, but not in orderly arrangement.

In 2019, the town area has grown to 10.19 square kilometres (1019 hectares) due to the rural areas such as Pyinphyumaw and remaining portion of Taungyin villages namely as Taungyin Group were upgraded to town level because of relative proximity to the commercial center and easy access to these areas. Although rural population decreased, the urban population increased to 34065 in this year, representing a density of 3343 persons per square kilometres. The average growth rate in that period was 2.0 percent which showed slight increase compared with the previous 23 years.

Table 1 Urban and rural population in Kyaukphyu Township

Year	Population			Urban population growth rate %
	Urban	Rural	Total	
1958	14447	77230	91677	
1973	17899	90121	108020	1.0
1996	23192	131530	154722	1.3
2019	34065	128843	162908	2.0

Source: Department of Labours, Immigration and Population, Kyaukphyu

Urban extension

The growth of town is fairly systematic. The extension areas of the town are:

Ceditaung Extension

This extension area is located on the eastern side of the road linking the town center and Kalabartaung Village and north of the Kalarbartaung-Kanyintaw Street. It forms as part of Ceditaung Ward. The aerial photos of 1958 reveal no trace of settlement in this area. It was in 1965 that plots of land for each family were systematically arranged over 32 hectares of land. In 1996, another 16 hectares were added to the area and it increased to 304 plots. In 2019, it occupied 49 hectares with 727 plots.

Sanpya Extension

This extension area was once paddy land. In 1978, it was transformed into residential land as part of Officers Ward. It is located on the eastern side of Kyaukphyu-Ngalapway Road and on the western side of Kyaukphyu-Kalarbartaung Street. With an area of 47 hectares, it has 249 plots

for settlement units. It can be identified with the aerial photo taken in 1983, as it was established since 1978. In 2019, the total area of Officer Ward with Sanpya Extension was 86 hectares.

Taungyin group

Taungyingyi and Taungyinnge Extension

Formerly Taungyin Extension area was part of Taungyin Village and had no houses over it. When a plant site was chosen near the No. 2 harbour, part of the existing settlement was included in the project area. As a result, about 100 houses had to be removed to the open space of Taungyin Village. At the beginning, these houses were not in grid arrangement. In 1979, 390 plots were systematically demarcated, using over 61 hectares of land.

Taungyinge Extension is separated by one-hectare-wide bazaar called Zayaroo from Taungyingyi Extension. It is located beside the Kyaukphyu-Ngalapway Road and to the north of Fish Technical School. Its area is 20 hectares and was systematically divided into 192 plots in 1984-85.

For the benefit of service personnel, 225 plots over 9 hectares of land area were arranged near Kalabartaung Village.

In 1996, plots of land were arranged over the suitable land of Gonechain Village and given to the families of the army personnel of 542 and 543 regiments.

In February 2019, Pyidaungsu Hluttaw approved the recognition of Taungyingyi, Taungyinnge, Saytiya, Ngalapway, Kanyintaw and Kalabartaung villages included in Taungyin Village Tract was included in the Kyaukphyu Town area under the name of Taungyin Ward Group. Besides, Pyinphyumaw Village located on the eastern portion of the town was included in the kyaukphyu town area. Since then, the number of wards in Kyaukphyu Town has been 17 up till now (2019-2010)

Source: Department of Agricultural Land Management and Statistics (Kyaukphyu)

Figure 2 Ward boundary of Kyaukphyu Town (2019)

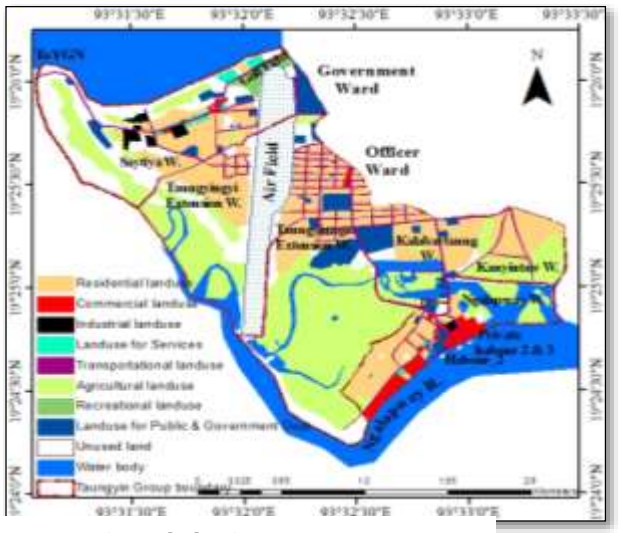


Figure 3 Land use of Taungyin Ward Group Town (2019)

Land use change

The urban land use of Kyaukphyu town comprises residential land use, commercial land use, industrial land use, land used for public and government department, land used for services, agricultural land use, transportational land use, recreational land use and unused land.

The land area occupied by residential building was 72 hectares in 1958 and it increased to 125 hectares in 1996 and 297 hectares in 2019 respectively. Among extension wards, Sanpya and Ceditaung wards have more concentrated houses due to their locations close to the business centre.

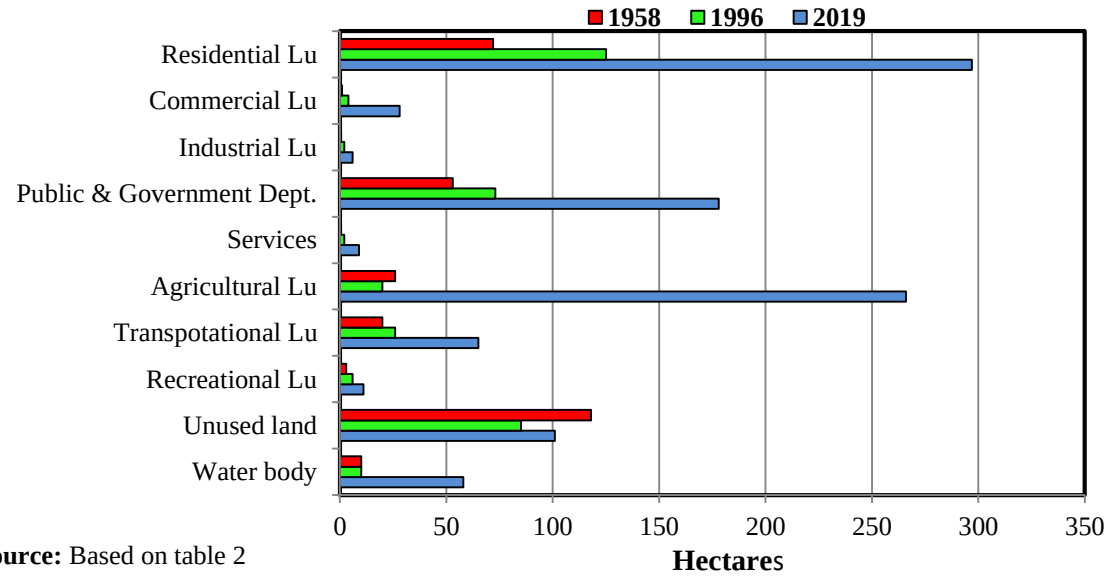
There was 1 hectare of land used by commercial purposes in 1958 it increased to 4 hectares in 1996. In 2019, the commercial land use covered 28 hectares, representing 2.7 percent of the town area. The commercial land use is manifested by two large markets, two bazaars, near the habour no. 2 and 3 in Ngalapway Ward.

Industrial land use includes rice milling, food production, purified drinking water production, ice production, saw milling, paper recycling, printing and small cottage industries in Kyaukphyu. There was small cottage industrial land use in Thanpanchaung Ward occupying 0.5 hectares in 1958. The ice factory as industrial land use located on Kanner Road in Government Ward occupied 2 hectares of land in 1996. After 2000, ice production factory was ceased and it was converted to Fishery Department. In 2019, 6 hectares of industrial land uses are found along the Yangon-Kyaukphyu Road in Saytiya Ward.

The unused land of the town occupies the areas with bog soil, saline soils, and discarded lands not suitable for land use. This type of land is scattered all over the town. Other land use changes are shown in Table (2).

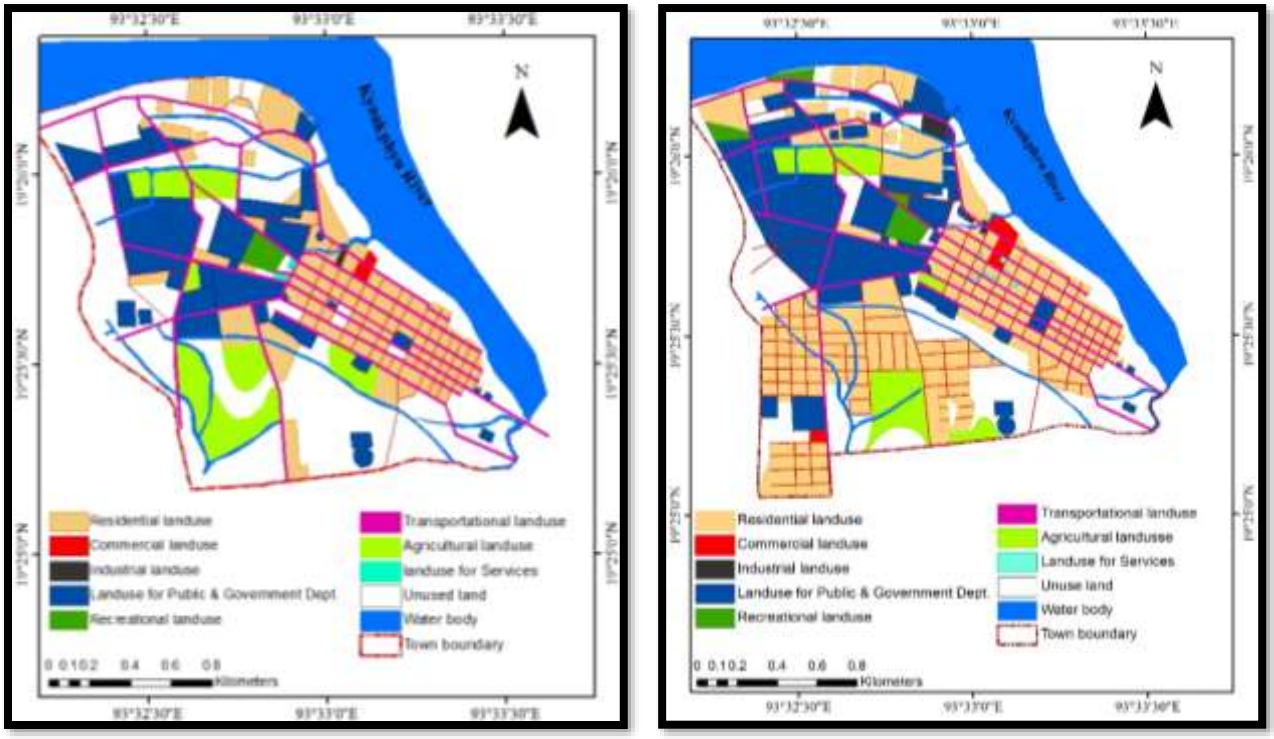
Table 2 Land use type of Kyaukphyu (1958, 1996 and 2019)

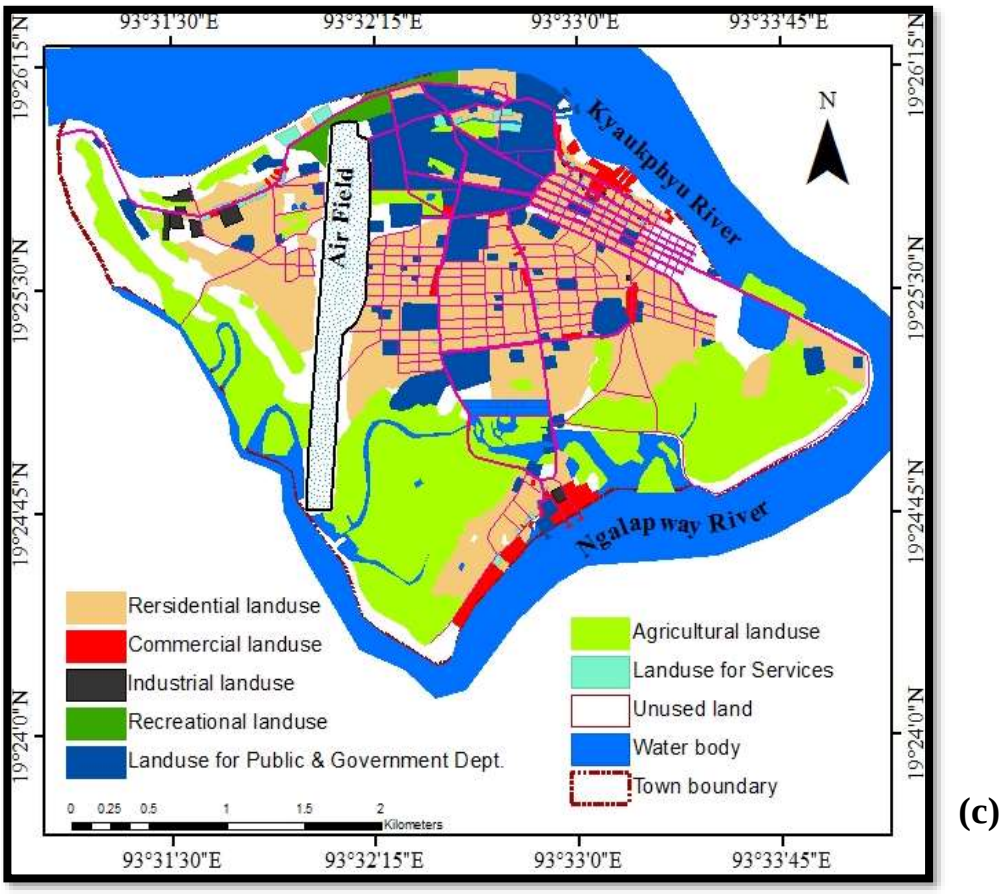
Land use types	1958	%	1996	%	2019	%
Residential land use	72	23.7	125	35.3	297	29.1
Commercial land use	1	0.3	4	1	28	2.7
Industrial land use	0.5	0.2	2	0.6	6	0.6
Land used for Public & Government Dept.	53	17.4	73	20.6	178	17.6
Land used for Services	0.5	0.2	2	0.6	9	0.9
Agricultural land use	26	8.6	20	5.6	266	26
Transportational land use	20	6.5	26	7.3	65	6.4
Recreational land use	3	1	6	1.6	11	1.1
Unused land	118	38.8	85	24.1	101	9.9
Water body	10	3.3	10	3.3	58	5.7
Total Area (Hectares)	**304**	**100**	**353**	**100**	**1019**	**100**



Source: Based on table 2

Figure 4 Land use types of Kyaukphyu (1958, 1996 and 2019)





Source: Department of Agricultural Land Management and Statistics (Kyaukphyu)

Figure 5 (a, b and c) Urban Land use of Kyaukphyu Town (1958, 1996 and 2019)

Anthropogenic Pressure on Landuse Change

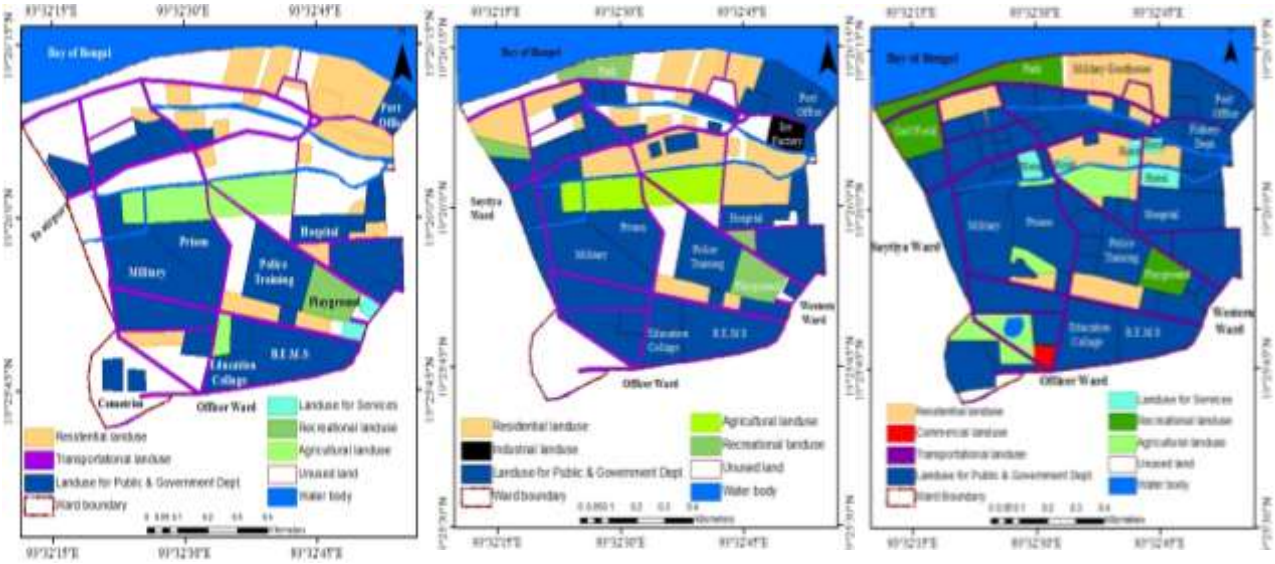
Factors affecting the land use change

There are three main factors of anthropogenic pressures affecting the land use change in the study area. These are social factor, economic factor and political factor.

Social factor

All land use change due to social factor is more apparent in Government Ward. Government Ward has government offices, non-government offices, organizational buildings, banks, hospital, Educational College, schools, hotels, home for aged and guest-houses. The residential buildings gradually filled the vacant land. After the year 2000, some houses were removed from the ward, keeping only buildings related to government services. Some government service personnel reside at their respective offices.

The land area used for public and government was 31.8 hectares in 1958 and it increased to 43.2 hectares in 1996 and to 61.6 hectares in 2019, occupying 66 percent of the total Government Ward area.



1958 **1996** **2019**

Source: Figure prepared presenting data from Department of Agricultural Land Management and Statistics (Kyaukphyu)

Figure 6 Urban landuse changing by social factor in Government Ward (1958, 1996 and 2019)

Economic factor

Among the land use change due to the economic factor, commercial land use is more obviously in the study area.

Commercial activities, trade and industrial growth are major cause of land use change in the study area.

The transportation of Kyaukphyu Town is facilitated by one airfield, two state-owned ports, 3 private-owned ports and Kyaukphyu_Yangon Road. Trading business is the main economic activity of the town.

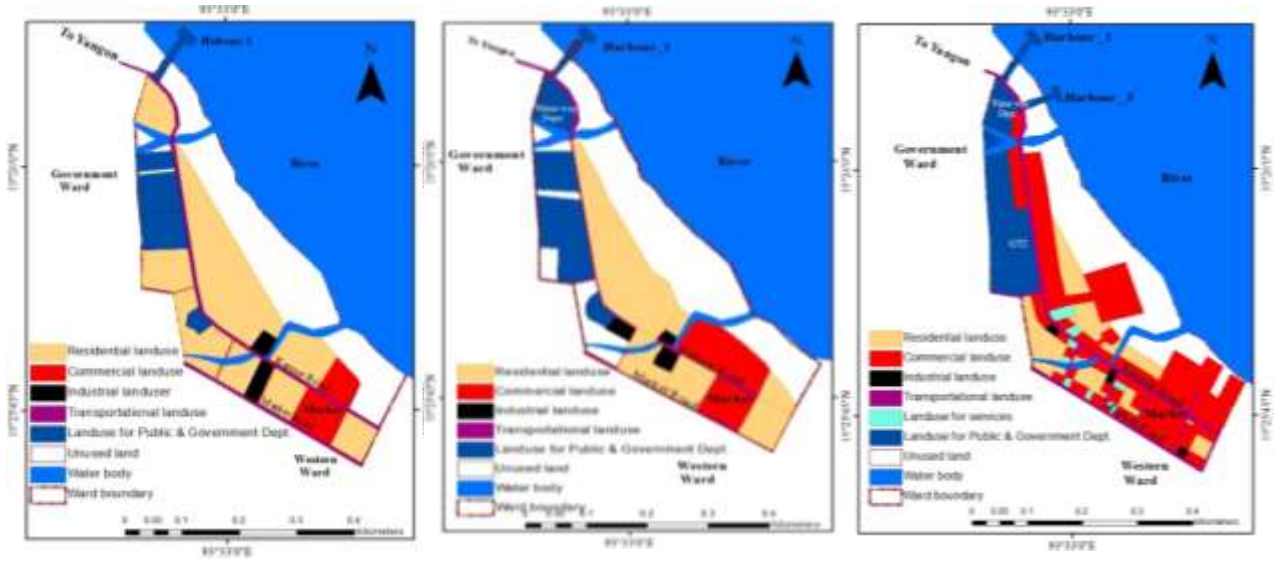
Myoma Market, the main distribution centre of foodstuffs and household goods, is located in Thanpanchaung Ward beside the bank of Kyaukphyu River. In 1992, Pyitharyar Market was open on the next road close to Myoma Market.

Fish and prawn farming have become more important having a number of streams and being close to the sea. There are various sizes of fish and prawn depots in Thanpanchaung Ward. As a result, commercial land use change is more pronounced in Thanpanchaung Ward.

In 1958, the land area used for commercial purpose was only one hectare, but it increased to 2.1 hectares in 1996 and to 5.9 hectares in 2019, representing 36.9 percent of the area of Thanpanchaung Ward.

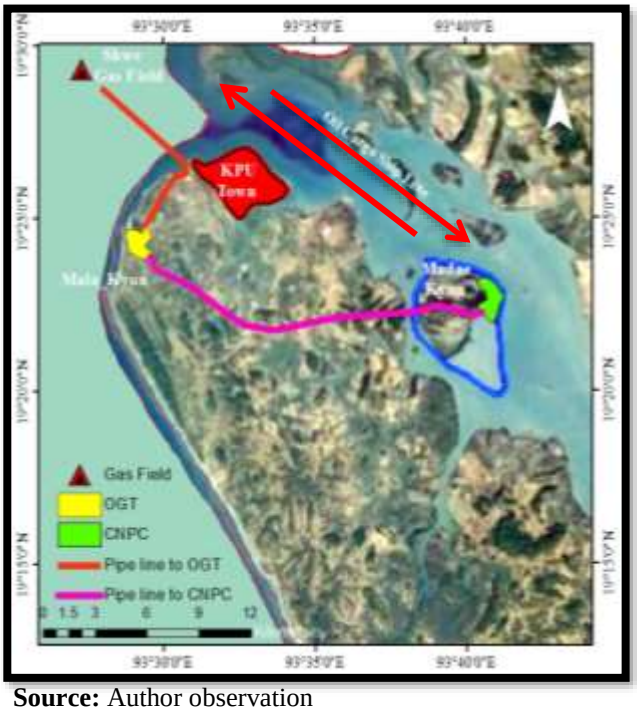
Ngalapway Ward, included in Taungyin Group has 3 ports. It is located by the Ngalapway Creek and one port is used for transportation of people and the other two for carrying consumer's goods and construction materials. These are deep-sea ports and thus large ships can come and go into the docks, enhancing the change in the commercial land use.

The main change in commercial land use is related to "Shwe Natural Gas Field". The site of natural gas field was discovered in 2000 and China National Petroleum Corporation (CNPC) has the right to produce the natural gas. The natural gas field is located 105 kilometres to the northwest of Kyaukphyu Town. The gas produced from the field is sent by underground pipeline to Onshore Gas Terminal (OGT) near Malakyun Village for purification. The purified gas is then sent to CNPC headquarter at Madae Kyun after crossing Kandi, Kyattain and Ookhin village tracts with underground pipeline from which it is sent to China by pipeline across central part of Myanmar. The production work is carried out mostly by Chinese workers and hotels and shopping centres have emerged for the employees, resulting in the change in the land use of commercial purpose.



Source: Figure prepared presenting data from Department of Agricultural Land Management and Statistics (Kyaukphyu)

Figure 7 Urban land use changing by economic factor in Thanpanchaung Ward



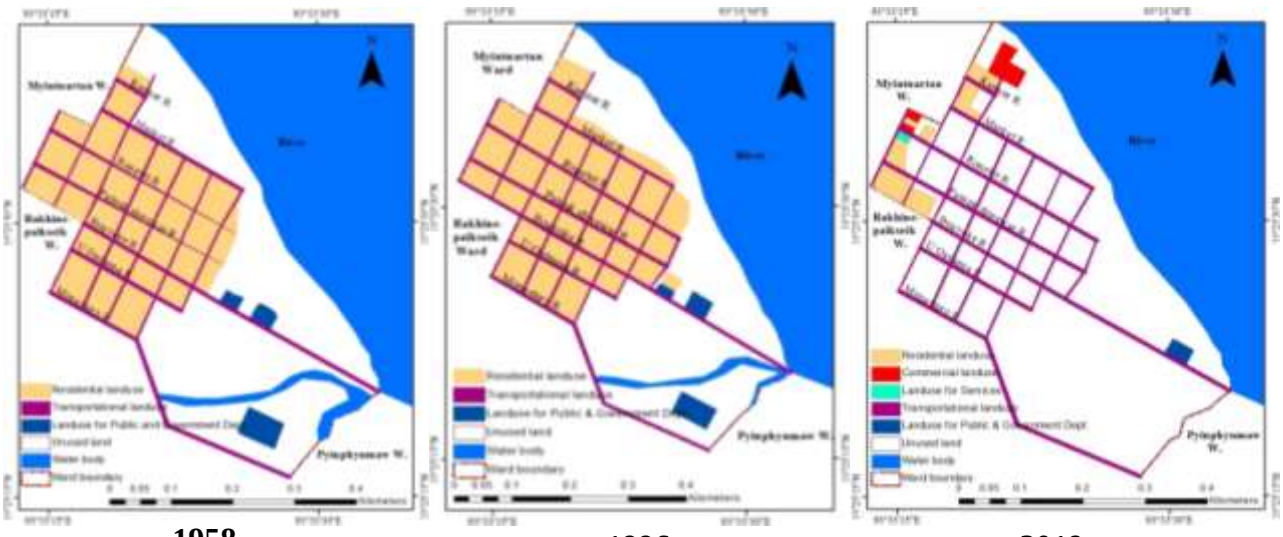
Source: Author observation

Figure 8 Location of Shwe gas pipeline in Madae Kyun, Kyaukphyu Township

Political factor

Residential land use change occurred in Kalar paikseik Ward located in the northeastern part of Kyaukphyu Town essentially due to political factor.

Due to disruptive event that occurred in April' 2012, about 300 houses from the ward was removed to Gonechin Village outside the town area. Currently (2019), most of the area of the ward remained vacant with no buildings. The residential land area in Kalar paikseik Ward in 1958 was 8.5 hectares and it increased to 12.7 hectares in 1996, but was decreased by about one hectare in 2019 due to the above-mentioned event. The remaining houses in the ward belong to the ethnic nationals.



1958 **1996** **2019**

Source: Figure prepared presenting data from Department of Agricultural Land Management and Statistics (Kyaukphyu)

Figure 9 Urban land use changing by political factor in Kalarpaikseik Ward

Land Value of Kyaukphyu Town

The process of urbanization in Kyaukphyu town based on its infrastructures, type of building and proximity of central commercial area. The central commercial area of Kyaukphyu is situated between Bogyoke Aung San Road, Kanna Road, Cross Road No.1 and Cross Road No.5. A plot of land having and area of 40′ x 60′ is worth 20 lakhs in 1996 and it increased to 3300 lakhs in 2019.

The land area that lies between Bogyoke Aung San Road, Monastery path, Education Office Road and Cross Road No.8 ranks second in value. Each plot of land within the area costs 5 to 10 lakhs in 1996 and it rose to 2400 lakhs in 2019.

The third most valuable land area is between Monastery Road, Market Road, Cross Road No.8 and Cross Road No.10. The price of a plot land in this area was 3 to 6 lakhs in 1996 and the current price of this area is 1800 lakhs.

The land along the Kyaukphyu- Ngalapway Road, particularly from the town towards Ngalapway Ward are at present commercial area and plot of land are relatively large. The value of each plot of land is about 1000 lakhs.

Excepting such special case, the land value of Kyaukphyu Town gradually become lower away from the central commercial area.

Trend of Urbanization and Economic Development

The area of Kyaukphyu Town has been increased with the increasing number of populations. Some areas of residential land were converted to commercial, services and industrial lands, and agricultural land to residential land.

The development of an area depends on the economic progress. In 1997, Myanmar, in cooperation with Japan Development Institute (JDI), presented 8 suitable places for the establishment of Special Economic Zones (SEZ), including Kyaukphyu.

In October, 2012, Kinmyauk (Zinchaung Village Tract) area was prioritized in Kyaukphyu Township. Kyaukphyu Special Economic Zone includes Deep Sea Port Package, Industrial Package and Integrated Residential Project Package.

For the implementation of these projects, 1736 hectares of land have been fixed. The industrial zone is to be established at 8.5 kilometres south of Kyaukphyu Town comprising Kandi, Thaichaung, Kyattain, Katthapyay and Chaungwa village tracts.

The chosen area for integrated residential project is 12 kilometres south of Kyaukphyu Town including Chaungwa and Minpyin village tracts.

For deep sea port, the area near Thitpoketaung Village to the north of Madae Kyun is chosen. However, having no transparency in petroleum port of Madae Kyun and Shwe Natural Gas Pipeline Project leading to conflicts with the locals, land confiscation, and destruction of crops all hinder the implementation of SEZ in Kyaukphyu Town until now. It is hoped that the implementation task may start soon.

Impacts of Urban Growth and Economic Development

The urban growth and economic development of Kyaukphyu Town can be taken for granted, based on the expansion of Kyaukphyu town area, the increase in the area of commercial land use, the emergence of 3 private ports, the annual export of 12 million billion cubic metres of natural gas to China, the sending of petroleum to China from Madae Kyun by pipeline across Myanmar since April, 2017.

Positive impacts

The above-mentioned economic activities can create more job opportunity to the local inhabitants and the country earns more foreign exchange. The number of service activities, hotels and retail shops has increased.

Negative impacts

The following negative impacts are pronounced due to urban growth:

- The rise of residential land price
- Less job opportunity for the locals, as more Chinese workers are being employed in the construction work of natural gas pipelines
- The confiscation or the grabbing of lands from farmers without paying compensation
- The invasion of salty seawater into the croplands due to the break of embankment in laying gas pipelines
- Conflicts between the local people and Chinese as the latter neglect the social customs of the local people
- Fire breaks out two time at waste dumpsite in 2018
- The quality degradation of natural environment and marine resources due to the possibility of oil spill. Crude oil from Middle East is sent to China by pipeline through Madae Kyun Port of Kyaukphyu Town. The large oil tanker with a carrying capacity 300,000 tons usually passes near Kyaukphyu Town so far, such tanker has passed 119 times. In 2018, oil spill event occurred near Madae Kyun, but the amount of spilt oil was limited and the pollution of seawater around the area was not conspicuous.

Conclusion and Suggestions

Kyaukphyu Town is located in the northern extreme of Yambye Island. The area of the town has expanded in response to the increasing population. The main economic activities of the town are trading, commercial activity and serving as the centre collection and distribution of prawn and fish.

As a result of the economic activity of oil and natural gas production and shipping to China, commercial land use change has occurred in the urban area of Kyaukphyu.

The project for implementation of SEZ in Kyaukphyu has been prepared and more land use change may result in after the completion of the project.

SEZ can generate more wastes and toxic materials and thus it is necessary to include the systematic waste disposal arrangement and treatment of industrial waste water at the respective industrial sites. Therefore, awareness raising talks should be carried out and discuss with the local inhabitants before the materialization of the SEZ project to maintain the quality of environment.

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 Kyaukphyu Township for aiding me in the collection of data concerned and their help in my field work.

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ကျောက်ဖြူမြို့နယ်ဖြစ်စဉ်မှတ်တမ်း၊ မြို့နယ်ပြည်သူ့ကောင်စီ (၁၉၆၂) ခုနှစ် ။

ကျောက်ဖြူမြို့နယ်ပထဝီဝင်အနေအထား၊ ကျောက်ဖြူမြို့နယ်အုပ်ချုပ်ရေးမှူးရုံး ။

စိုက်ပျိုးရေးနှင့်လယ်ယာမြေစီမံခန့်ခွဲရေးနှင့် စာရင်းဇယားဦးစီးဌာန ၊ ကျောက်ဖြူမြို့နယ်။

တင်တင်မြင့် မ၊ ၁၉၈၆ ၊ ကျောက်ဖြူမြို့နယ်၏ ဒေသန္တရပထဝီဝင်၊ ရန်ကုန်တက္ကသိုလ် ။

မြကျွန်းသန္တာ (၂၀၁၈), ကျောက်ဖြူမဂ္ဂဇင်း၊ အမှတ် ၅၊

GROUNDWATER AS A MAIN SOURCE OF DOMESTIC USE IN HINTHADA TOWN, AYEYARWADY REGION

Khin Kay Khaing[1], Wai Phyo Hlaing[2]

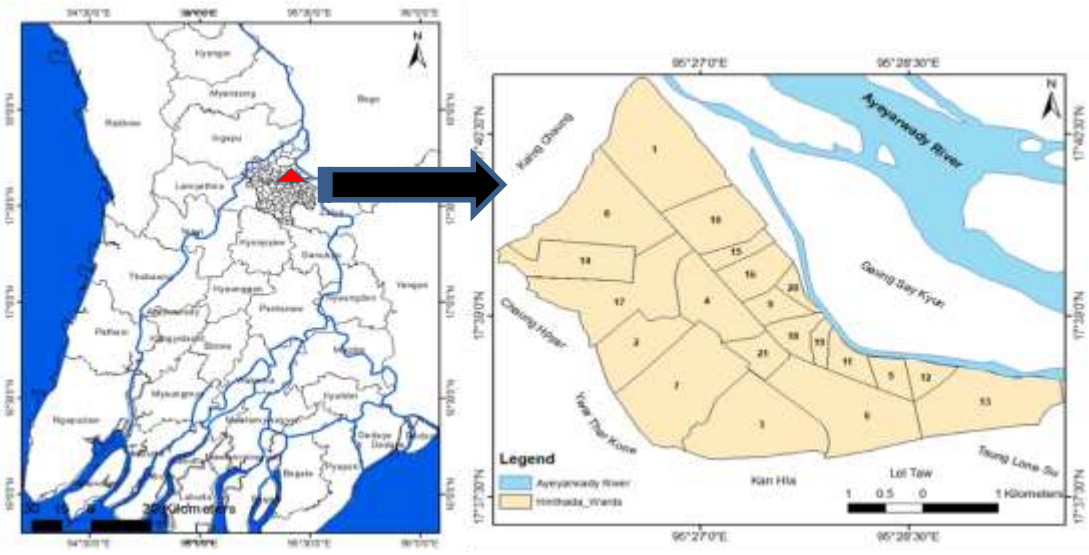
Abstract

Ayeyarwady Region is undoubtedly of great economic importance to the country by agriculture and fish productions. Hinthada Township is one of the 26 townships of Ayeyarwady Region, located on the western part of Ayeyarwady River. The total population of the Town is 80,117 in 2018. Most residents use water from groundwater source. There is no systematic water supply system. According to field survey, most of residents depend on rain water in the rainy season and ponds, opened-surface wells, shallow tube wells (hand pump) and deep tube wells and Ayeyarwady River for domestic use. Many households have their own tube wells and brick-lined wells in their houses but the water from most of them does not have good quality and is not suitable for drinking purposes. This study aims to determine the main water source for domestic and drinking uses of the residents and to make an assessment on peoples' perception on quality of their available water. Although both primary and secondary data are used, the main data from questionaries' survey and interview is used in the study. Systematic random sampling method is used to collect data. According to the result, groundwater is main water source for domestic use of residents of Hinthada Town. 97% of domestic water is from groundwater. Groundwater withdrawal is made by tube wells and hand pump wells. The chemical quality of groundwater is not exactly known well but people usually use traditional methods of at least one night keeping sedimentation with the aid of sedimentation tanks for the purpose of filtering and cleaning.

Keywords: Sources of water, groundwater, domestic use, water quality, people perception

Introduction

Ayeyarwady Region is undoubtedly of great economic importance to the country. Hinthada Township is located on the western part of Ayeyarwady River at north latitudes 17º 15′ - 17º 39′; east longitude 95º 13′ - 95º 35′. The Town area is approximately 17.82 square kilometer.



Source: Land Record Department, Hinthada, Checked Google Earth, 2019

A. Hinthada Town in Ayeyarwady Region **B. Location of wards in Hinthada Town**

Figure 1 Study area, Hinthada Town in Ayeyarwady Region

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Hinthada Town is composed of twenty-one wards. The total population of the Town is 80,117 in 2018. By the geology map of Myanmar Geoscience (2001), rocks units in Ayeyarwady Region composed of the rocks of Triassic to Holocene newer alluvial. Hinthada Town is mainly composed of Newer Alluvial. Being part of the structural basin of Central Myanmar, the relief of town is characterized by lowland plain. The old rocks of Rakhine Yoma are overlain by the younger deposits brought down by the Ayeyarwady River system. Above it are the valley-filled deposits mainly composed of sands and gravel interceded with clayey layers (Thet Thet Lwin, 2013). These sediments are found at the depth of 10 to 65 feet. According to the koppen's system of climate classification, its climate falls within Tropical Savanna (Aw) which receives heavy rain in June, July and August.

There is no water supply system distributed by Hinthada Town Development Committee. According to field survey, most of the residents depend on rain water in the rainy season and ponds, opened-surface wells, shallow tube wells (hand pump) and deep tube wells and Ayeyarwady River for domestic use. The proportions of domestic water use from these sources in Hinthada Town vary from place to place in accordance with the nature and situation of wards' location. Many households have their own tube wells and brick-lined wells in their yards but the water from most of them does not have good quality and is not suitable for drinking purposes. Majority of the residents buy bottled-water for drinking purpose and use the water from their wells for domestic use other than for drinking. Most residents use groundwater source. Although the primary sources are the same, the availability of residents vary locally and even spatially. This study intends (1) to determine the main source of water on which the residents depend high proportionately for their domestic and drinking uses and (2) to make an assessment of peoples' perception on quality of their available water.

The three main research questions for this study are

1. How many sources of water for domestic consumption are there in the study area?
2. What is the main type of water sources of residents of Hinthada Town?
3. What are the ways of local water treatment for available water quality?

Data, Methods and Methodology

Primary data is used and collected by questionnaires. Field survey and interview methods are also applied to complete investigation of sources of water, water availability, and perception on water quality. A set of questionnaires is designed after preliminary field survey to get facts and figures. By using questionnaire, the research work facilitates with fair cost for collecting a large volume of data.

Before undertaking the work of detailed questionnaire data collection, pilot survey has been carried out in different wards. Based on information obtained from pilot survey, questionnaires related to different types of water consumption are prepared. The questionnaire is arranged 27 sub-questions. After setting questionnaires, a sample size is determined by using formula devised by **Calderon and Gonzales** (1993). Systematic random sampling method is used to distribute questionnaire. Questionnaires are distributed to the wards in March to June, 2019. In the distribution of the questionnaires, the wards are stratified by street and number of questionnaires distributed in each ward is proportional to its total houses. The questionnaires are distributed by the help of ward leaders. Instead of pure random sampling, systematic stratified sampling method is mixed by which one in every 6 households is chosen. GIS software for distribution maps and descriptive and inferential statistic methods for data analysis are used.

Secondary data such as Google Earth map, various official records, research outputs, departmental reports and research papers are used for data of location, local climate, hydrogeology, population, water resource management, water related problems and sanitation.

Result and Discussion

Available types of water sources

According to the survey result, 7-types of available water sources found in Hinthada Town are R-Rain, P-Ponds, AR-Ayeyarwady River, BW- Brick lined wells, TW-Tube wells, HP-Hand pumped wells, and C-HP- Community hand pump wells. Every ward do not receive water from all these sources. Available types of sources vary spatially. Not every ward located nearby the river use river water. However, in the study area, nearly every ward has surface wells, hand pump and tube wells. Some wells belong to the private while others serve as community water source. The depth as well as quality of water varies from place to place. The following Table shows the spatial variation of available types of water sources, based on field survey records.

Table 1 Types of available water sources

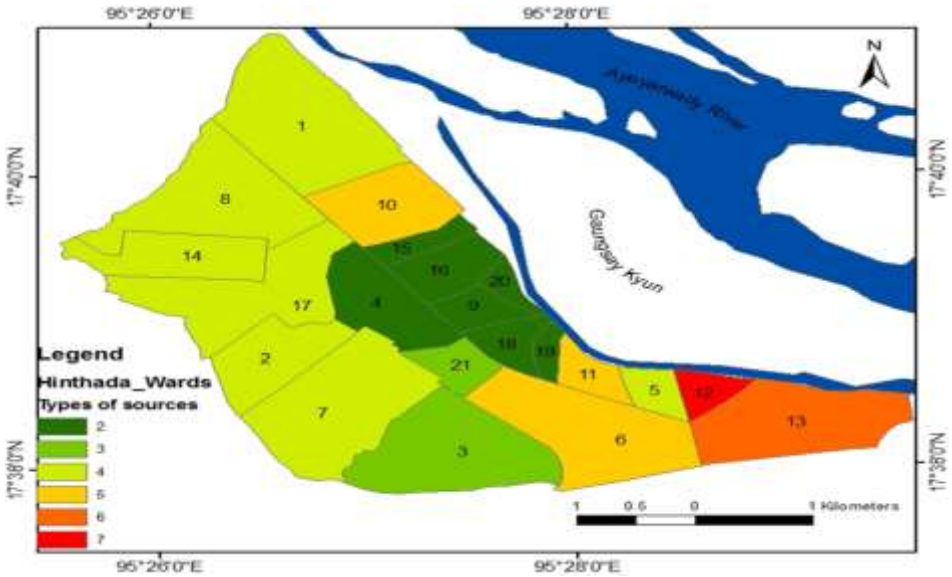
Index No. on Map	Wards Name	Types of available water sources	No. of sources
1	Pyin Ma Chaung	R, AR, TW, HP	4
2	Mya Wa Di	R, TW, HP, BW	4
3	Pan Be Dan	R,TW, HP	3
4	Pa Da Myar	R,TW	2
5	Za Kar	R, P,TW, BW	4
6	Tar Ka Lay	R, AR, TW, HP, BW	5
7	Ka Naung Su	R,TW, HP, BW	4
8	Le Ti Kwin	R,TW, HP, BW	4
9	Yone Gyi	R, TW	2
10	Nyaung Pin	R, AR, TW, HP, BW	5
11	Shwe Ku	R, AR, TW, HP, P	5
12	Kin	R, AR, TW, C-HP , HP, P, BW	7
13	Pa Khan	R, AR, TW, HP, P, BW	6
14	Aye Mya Thar Yar	R, C-HP, HP, TW	4
15	Tar Ngar Se (N)	R,TW	2
16	Tar Ngar Se (S)	R,TW	2
17	Thone Pin Kwin	R, HP, TW, BW	4
18	U-Yin (N)	R, TW	2
19	U-Yin (S)	R, TW	2
20	Let Tha Mar	R, TW	2
21	Hpa Yar gyi	R, TW, HP	3

Source: Questionnaire survey

Notes : R-Rain water, P-Ponds, AR-Ayeyarwady River water, BW- Brick line wells, TW-Tube wells, HP-Hand pumped well, C-HP- Community hand pump well

According to the respondents of Kin Ward, it was observed that they use water from 7 types of sources and also known that Pa Kham Ward with 6 types of sources and Tar Ka Lay, Nyaung Pin and Shwe Ku wards have 5 types of sources. Another 7 wards use water from 4 types of sources and 3 wards use from 3 types of water sources. 2 types of sources are used by 7 wards. Spatial variation of available type of sources can be seen in the following figure 1.

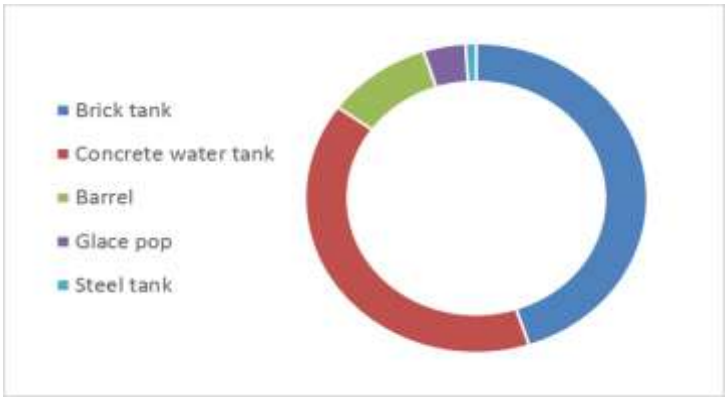
Actually the wards which used less number of water sources will possess the effective type of water sources. As they can use from only one or two sources sufficiently, they do not need to withdraw from other sources. Some wards like Kin, Pa Khan, Tar Ka Lay, Nyaung Pin, Shwe Ku cannot receive sufficient water from one or two types of sources. So they apply multi types of sources; Brick-lined wells, hand pump wells, community hand pump wells, tube wells, pond, Ayeyarwady River; by searching better types of water sources



Source: Based on table 2.1

Figure 1 Spatial variation of available types of water source.

The nature of water storage containers that use in Hinthada Town also vary. The most households use brick tanks and concrete tanks (45 % and 40 % of total households) and followed by barrel (10 % of total households), glaze pops and steel tanks. Figure 2 shows the water storage containers that use in all households of Hinthada Town.



Source: Questionnaire survey, May 2019

Figure 2 Percent share of water containers used in households of Hinthada Town

Water use from different sources

According to respondents, rain water is used by all the households of the 21 wards in the rainy season. Some use throughout the year by storing it. Based on the responses during field surveys, some households want to use rainwater all year round, but they do not take effort to store the water, while some households have no large earthen jars, brick tanks, steel tanks and large plastic bucket. The households that store rainwater use it for drinking as boiled water. There are totally 31.4% of households that use rain water in rainy season for the whole township. Of which, about 3.1 % store it for dry season use. However, a few household (2.6% of total) stores rain water for the whole year use.

Surface water in Hinthada Town is acquired by two types of water sources as river and ponds. It is found that the river water is used by the residents of 6 wards. They use for cooking, washing and bathing. However, not all the households of these wards use river water. Only the households close to the river, and when they are flooded by river, they use it for domestic purposes. River water is used mainly in the rainy season. The following table 2 shows the percentage of household that use river water for domestic purpose.

Among the 21 wards, only 4 wards use pond water. Pond water is acquired by laying pipeline and pumped it with motor to get into the house. It is used mainly for cooking, cleaning and washing. Some households of Pa Khan, Kin and Shwe Ku wards use it as boiled water for drinking. Groundwater in Hinthada Town is withdrawn by two types of sources that are (1) Surface wells (or) brick-lined wells and (2) Tube wells with hand pump (hand pump wells) and tube wells with motor (tube wells)

Nearly all residents in Hinthada Town use groundwater in all season for various purposes. Therefore, it can be said that the residents of Hinthada Town depend essentially on groundwater for their daily water consumption. Generally the depth of brick wells are between 10 feet to 20 feet and the depths of hand pump wells and tube wells are between 30 to 400 feet in the Hinthada Town. Therefore water from tube wells is withdrawn from various aquifers of both shallow aquifer and deep aquifer in the study area.

There are brick-lined wells which are one type of source of domestic water in Hinthada Town. According to questionnaire survey, the distribution of brick-lined wells are found in 9 wards as shown in Table 2. In accordance with this table, brick-lined wells are widely distributed in wards of Hinthada but, their value on the use of domestic water for residents are not significant. The maximum number of households that use brick-lined wells as sources of domestic water are 7 % of total households of Za Kar Ward, followed by Nyaung Pin, Pa Khan, and Thone Pin Kwin by 4 %, and 3 % of total household respectively.

Table 2 Percentage of households using water from main different types of water sources

Index No	Wards	P%	AR%	BW%	C-HP%	HP%	TW%
1	Pyin Ma Chaung		14				100
2	Mya Wa Di			3		2	96
3	Pa Be Dan					2	97
4	Pa Da Myar						100
5	Za Kar	24		7			100
6	Tar Ka Lay		1	2			99
7	Ka Naung Su			1		1	97
8	Leti Kwin			1		1	94
9	Yone Gyi						100
10	Nyaung Pin		14	4	3	7	91
11	Shwe Ku	8	28			27	73
12	Kin	19	8	2	4	23	73
13	Pa Khan	10	13	4		10	100
14	Aye Mya Tha Yar				27	3	97
15	Tar Ngar Se (N)						100
16	Tar Ngar Se (S)						100
17	Thone Pin kwin			3	1	1	99
18	U-Yin (S)						100
19	U-Yin (N)						100
20	Let Tha Mar						100
21	Hpa Yar Gyi						100

Source: Questionnaire survey, May 2019

Water from hand pump wells are used more or less in nearly all wards in Hinthada Town. There are community hand pump wells as well as private hand pump wells in Hinthada. The use of water from hand pump is due to two main reasons. One is its availability even when the electric power is interrupted and another is that it is not so expensive to sink it as deep tube well. There are 10 wards that use hand pump well in Hinthada Town (Table 2). Hand-pump wells were primarily developed in Hinthada long ago and later, they have been transformed to motorized tube wells by the development of electricity. At present, nearly all household has tube wells. There are also some community hand-pump wells which are used by households which cannot effort to own private wells. According to questionnaire survey, tube wells are found in all wards of Hinthada Town. But, households of 7 wards (Pa Da Myar, Yone Gyi, Tar Ngar Se (N), Tar Ngar Se (S), U-Yin (N), U-Yin (S), and Let Tha Mar) use their domestic water only from tube wells. The depth of the tube wells varies due to the variation in the depth of acquirer and the amount of money used in sinking tube wells.

The original sources of domestic water in Hinthada Town are rain water, surface water and groundwater but local people acquire water from these sources by 7 different types and they also use purified drinking water as well. Among them rain water is seasonal and availability of purified drinking water depends on the consumer choice for drinking water source and ability for purchasing. Except rain water, the dominant type of water sources with percentage of households consumed is based on 6 types of water sources. Table 3 shows ward-wise share of domestic water use from main types of water sources. Among the 6 different types of sources, water from tube well is the main source of domestic use in all wards of the town. According to responses to the

questionnaire survey, 97 % percent use water from tube wells, 4% percent from private hand pump wells. Therefore, a great majority of the urban residents of Hinthada depend mainly on the groundwater source for domestic uses. Tube wells are dominant types of available water sources as it is shown by table 3.

Table 3 percentage share of household water use

Types of water sources	Percentage of total	Original sources
using water from pond	2	Surface Water
using water from Ayeyarwady River	3	
using water from brick-line wells	1	Groundwater
using water from community hand pump wells	1	
using water from private hand pump wells	4	
using water from tube wells	97	

Source: Questionnaire survey, May 2019

Sources of drinking water in Study area

Questionnaire survey revealed that, purified bottle water is also used as drinking water in study area. Respondents of 12 wards; Pyin Ma Chaung, Pa Da Myar, Za Kar, Yone Gyi, Pa Khan, Tar Ngar Se (S), Tar Ngar Se (N), Lte Tha Mar, Hpa Yar Gyi, express that their main water source is 100 % from tube wells (Figure 3.B). But all households use purified water for drinking. As shown in Figure 4, the two main source of drinking water in Hinthada are purified bottle water and water from tube wells. For the whole town, 51% of total households drink purified bottle water and 46% drink water from tube wells and 3% from hand pump wells.

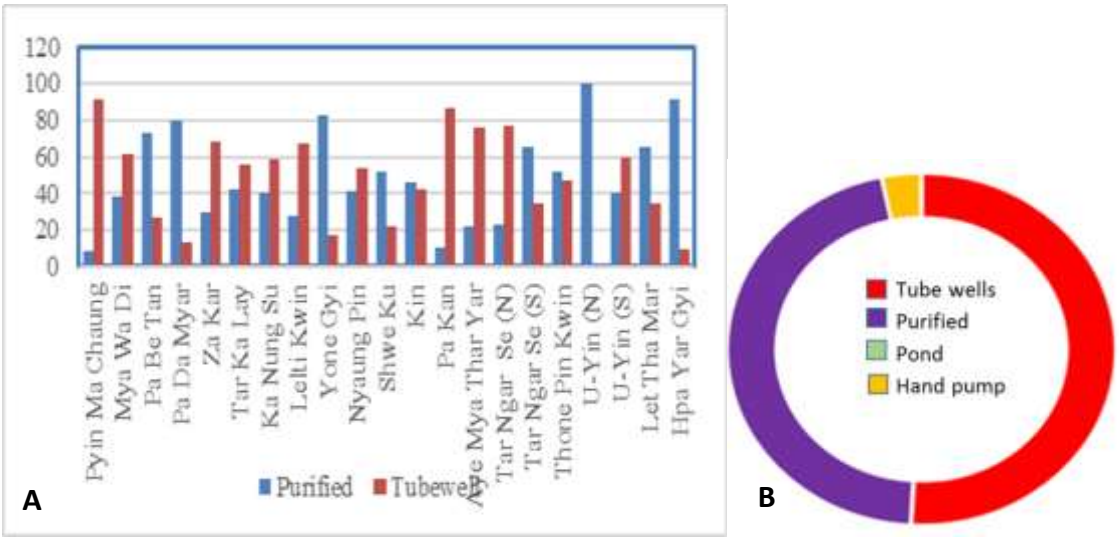
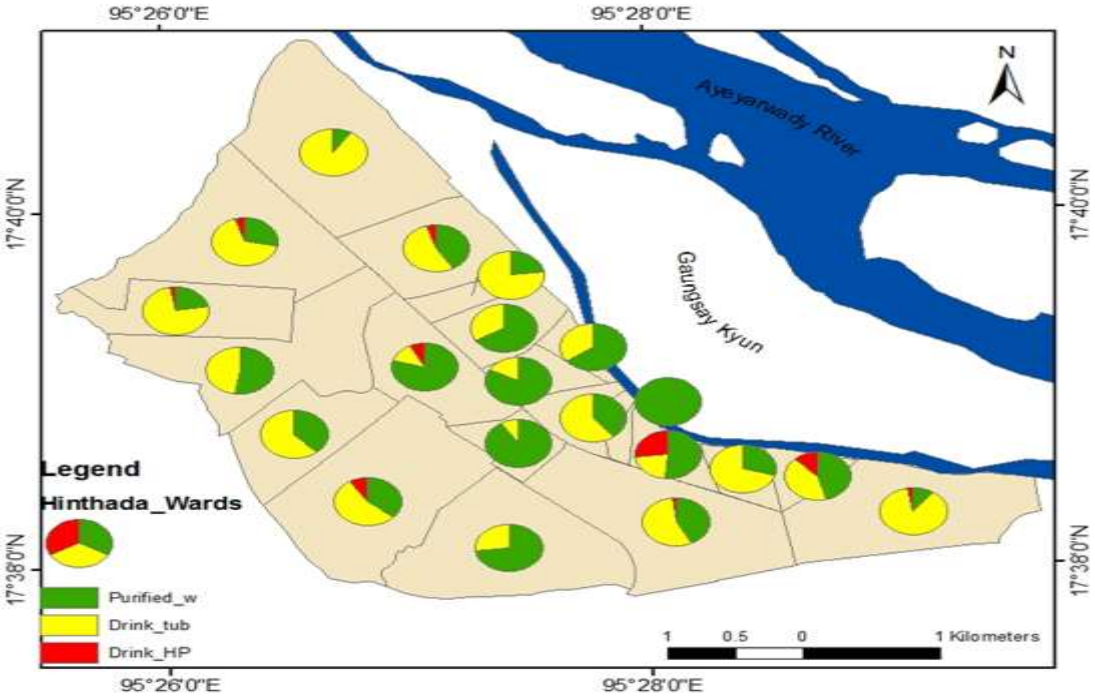


Figure 3 Ward-wise variation of sources for drinking water (result from Survey data)



Source: Questionnaire Survey

Figure 4 The ratio of drinking water sources in Hinthada Town

Groundwater situation and people's perception on water quality

The availability of groundwater varies with the changes in season. The change is more obvious between the rainy season and the dry season. According to questionnaires survey, the availability of groundwater decreases in all wards of Hinthada Town in the dry season. As most tube wells yield low amount of water in dry season, it takes more time to get sufficient water for domestic use. However the respondents of households located close to the river express as the yield of water is not different in the water. Some tube well close to the river automatically yield water without pumping as the water table rises close to the surface. Such situation is found at a household on Targyitan road in Kin Ward while is very close to the river. There has been no seasonal change in water availability from tube wells in Pyin Ma Chaung, U-Yin (North) and Hpa Yar Gyi wards. These wards are located near the Ayeyarwady River. The remaining 18 wards more or less have witnessed the seasonal variation of groundwater. These situation is learnt from questionnaires survey.

There are 97 percent of total households that use water from tube wells and 4 percent of total households use water from hand pump wells in Hinthada Town. 51 percent of total households drink water from their own tube wells and 3.2 percent of total households drink water from their hand pump wells. These situation is interesting to test the water quality of groundwater of Hinthada Town, to analyze the situation of tube wells and to check on the perception of local people on their water by both physical and non-physical that is taste, small, hardness etc. This study tried to analyze groundwater situation of Hinthada town by collecting all available data from primary and secondary sources that can represent the general picture of groundwater of study area. During the time of field observation, some of physical quality of water such as, water colour, sediments load in water, and changing colour by boiling water were observed. Most people can detect colour above 15 true colour units (TCU) in a glass of water and levels of colour below 15 TCU are often acceptable to consumers (Tin Nilar Soe 2018). Turbidity in water is caused by suspended particles

or colloidal matter. Inorganic or organic matter or combinations of the two are sources of turbidity in water.

According to field surveys, the depth of tube-well varies from 20 to 400 feet. The variation in the depth of tube-well is related to relief, geological structure of underlying rock strata and the depth of the existence of aquifer. Not only the depth but also the quality of water varies from place to place. A household in Mya Wa Di Ward has a tube well with a depth of 240 feet, but the groundwater quality is not potable. However, the tube well cannot be sunk deeps, being underlain by hard rock layer. The experience during field survey, groundwater yield from 30 of totally 109 households at Pa Khan Ward is also not potable. These households try to get good quality water by test-drilling one place to another within their compounds but they do not success and they do not get good quality water. Usually, the sinking of tube well ceased as soon as groundwater spring out from the tube, while other sunk deeps. However, some tube well with a greater depth do not yield potable water. Therefore, the depth varies mainly with the depth of aquifer that contains good quality water. A household on Bo Saw Maung road in Yone Gyi Ward receives potable water from the tube well with a depth of only 20 feet. However, some tube wells in Pa Da Myar Ward do not yield potable water although the depth is over 200 feet. Income also affects the depth of tube well. The households on Hanpin road of Ka Naung Su had to dig down to the depth of 270 feet, although income is low. If the depth is low, the tube wells would not yield good quality water so they use more input even though they are low income.

The responses of individual household vary significantly. The lowest 20 feet tube wells and the highest 400 feet are found in the Town. However, to get general understanding of depth of tube wells and the representative for value of all individuals are grouped into 5 such as tube wells with depth under 50, between 50 to 100 feet, between 100 and 200 feet, between 200 and 300 feet, and above 300 feet. There are 28 % of tube well with depth between 100 feet and 200 feet and 41 % of tube well with depth between 200 feet and 300 feet and they are widely distributed in the Town. Town-wise share of tube wells with different depth categories is presented in Table 4 and figure 5. Some households with low income have tube well with shallow depth, resulting in low water quality, but they use it by keeping tank for sedimentation to get fairly clean water.

Table 4 Percentage of total number of tube wells with different depth categories

<50ft	**Between 50-100ft**	**Between 100-200ft**	**Between 200-300ft**	**>300ft**
6 %	17 %	28 %	41 %	9 %

Source Questionnaire Survey, May 2019

In brief, there are four factors that affect the depth of tube well, they are:

(1) Types of underlying rocks,

(2) The depth and water storage capacity of aquifer,

(3) Quality of available groundwater and

(4) Income or the amount of money spent in sinking tube well.

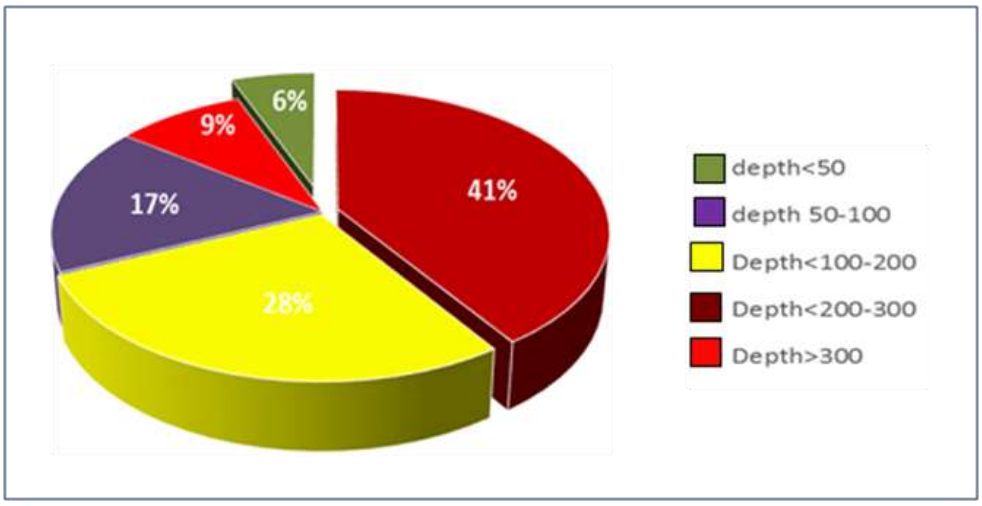


Figure 5 Town-wise share of tube wells with different depth categories

The different perceptions on the quality of available water are identified by the sample households. Some households on Kyawk Kone road of Pyin Ma Chaung Ward do not like the water they are using because of its yellowish colour. Likewise, some households on Khayay road in Mya Wa Di Ward do not satisfy the water being used as it turns to black colour although it is clean at the beginning. The depth of their tube well is 240 feet, but they have to keep sedimentation tank to get fairly clean water. Households on Thiri-8 road like the water that yields from shallow tube-well because of good quality water. According to talking with owner household, it can be drank just by keeping one night for sedimentation. A household on Shwe Myin Tin road does not like their water because sediments appear in several days. Some households do not like their water as it turns to rusty colour in a few days and the layer of calcium encrusted the cup and utensil used with this water. Water from some tube wells turned into red colour if it is boiled. Anaerobic groundwater may contain ferrous iron at concentrations up to several milligrams per liter without discoloration or turbidity in the water when directly pumped from a well. On exposure to the atmosphere, however, the ferrous iron oxidizes to ferric iron, giving an objectionable reddish-brown colour to the water. Iron also promotes the growth of "iron bacteria", which derive their energy from the oxidation of ferrous iron to ferric iron and in the process deposit a slimy coating on the piping. At levels above 0.3 mg/l, iron stains laundry and plumbing fixtures. There is usually no noticeable taste at iron concentrations below 0.3 mg/l. No health-based guideline value is also proposed for iron (WHO, 2011). In brief, the perception of users on the available water depends on the quality of water. The water users or the sample households dislike if the water they receive has the undesirable qualities. According to the open talk and interviews with residents, quality of groundwater in study area can be highlighted by following points.

(1) Having yellowish colour
(2) Having large content of sediments on solid particles
(3) Turning red when it is boiled
(4) Turning into black colour some time later after the withdrawal
(5) Turning yellowish colour in cooking rice
(6) Encrusting of calcium in the cup or utensil
(7) Having rest colour and rusty smell

In brief, water shortage problem occurs in wards which are located outside the embankment and due to floodwater that causes all the existing groundwater sources in these areas leading to

water shortage problem both for domestic uses and drinking. Some areas with remarkably low quality water and for some households that cannot effort to have own tube wells have to face with water shortage problem. Almost all households in Hinthada Town use sedimentation tanks for the purpose of filtering and cleaning. The following plates show such water sedimentation tanks of households as examples.

Plates showing the examples of sedimentation tanks that usually use for the purposes of sedimentation, filtering, and cleaning. Source: Photo© taken by Wai Phyo Hlaing

Conclusion

The climate of Hinthada Town in Ayeyarwady Region is monsoonal with the rainfall of nearly 2000 millimeter. Rain water is seasonal. Rain water collection ponds are not well developed. There is no water supply system distributed by Hinthada Town Development Committee. The residents prefer water from groundwater sources which can access easily when they can effort to sink tube wells. According to field survey, most of the residents depend on rain water in the rainy season and ponds, opened-surface wells, shallow tube wells (hand pump) and deep tube wells and Ayeyarwady River for domestic use. The proportions of sources of domestic water use in Hinthada Town from these sources vary from place to place in accordance with the nature of and situation of that area. The household water use in Hinthada Town comes from tube wells mostly private and lesser amount from hand pump wells. The depth of tube wells are different mostly (70 per cent of total tube wells) between 100 and 300 inches. About 97% of domestic water use is from groundwater source. Tube well is the main type of available water sources in Hinthada Town. According to survey results, the residents do not know well about the chemical quality of groundwater which they use. They know the water colour and sediments in water. But, as the traditional way whatever used by ancestors they treat one night keeping sedimentation and some people try to get good quality water by boiling.

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SUPPORT FOR ECONOMIC CONDITION FROM MIGRATION AND ITS EFFECTS IN PA- AUK AND KAWT KHA MEL VILLAGE TRACTS, MAWLAMYINE TOWNSHIP

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Abstract

Migration plays a vital role in poverty alleviation and rate of unemployment. According to questionnaire survey the migrants of the study area left their native because of low job opportunity and low salary or wage which cannot fully support the livelihood of the family members and education cost of their offspring. The main intention of leaving for neighbouring countries is to earn more income. This paper focuses on the migration flow, trend and movement which affect the socioeconomic life of the migrant workers' families. The research questions are: (1) "What are the socioeconomic conditions of the migrant workers?" and (2) "What extent the respective families depend on the remittance sent by the migrants?". Main aim of this paper is to examine the effects on economic progress of migrants' families. The objectives are: to identify the socioeconomic conditions of the migrant workers, to know the main reason of migration, and to assess the extent of dependency on the remittance sent by migrants. Primary data are acquired by providing questionnaire and discussion with the family members of 120 migrant workers. The data are analyzed by frequency and percentage methods as well as with SWOT Analysis to reveal opportunities, threats, strengths and weaknesses of earning income at the neighbouring states as migrant workers.

Keywords: migration, unemployment, remittance, rural area, SWOT Analysis

Introduction

Migration is a decision that impacts the welfare of the household, the home community, and in the end the whole economy in various ways (Azam and Gubert 2006). Migration and remittances have both direct and indirect effects on the welfare of the population in the migrant sending countries. While migration has economic, social, and cultural implications for the sending and host societies, remittances the migrants send home are perhaps the most tangible and least controversial link between migration and development (Ratha 2007). Mawlamyine is the capital city of Mon State and it is fairly developed because of its advantageous location and high accessibility with roads, railroads and airfield. In the study area, there are only a few households that depend on farmwork. Likewise, the numbers of workers engaged in weaving industry are also small. At least one member of each family or household is working in the neighbouring or other country and the majority of the households rely on the remittance sent back home by the migrant workers. Such existing infrastructural facilities as residential buildings, electricity and potable water sources, public rural health centre, clinics, basic education high school, University of Technology reveal that the study area is economically fairly developed. In order to have comprehensive understanding of the economic background of the area, this research work is conducted.

Research questions

What are the socioeconomic conditions of the migrant workers?

What extent the respective families depend on the remittance sent by the migrants?

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❖ Aim

- The main aim of this study is to examine the economic progress of migrants' families.

❖ Objectives

- to identify the socioeconomic conditions of the migrant workers
- to know the main reason of migration
- to assess the extent of dependency on the remittance sent by the migrants

Data and Methodology

The analysis is based on a survey of 120 migrants during the period from 25-12-2019 to 6-1-2020. Primary data which include gender, age, education, former and present job, income, marital status are acquired through questionnaire survey. The facts and information related to the migrant workers are responded by the family members of the respective migrant workers. Secondary data are obtained from Township General Administrative Department. The data obtained are assessed by sample statistical methods including frequency and percentage. In order to be able to present the good points and weaknesses of earning income as migrant workers, SWOT Analysis is used.

Study Area

Mawlamyine Township is located between north latitudes 16° 22′ and 16° 30′ and between east longitudes 97° 35′ and 97° 42′, covering an area of (230.04) square kilometres (88.82 square miles). It is (27.36) kilometres (17 miles) long from north to south and (11.27) kilometres (7 miles) wide from east to west. It is bordered with Hpa-an Township (Kayin State) on the north, Kyaikmayaw Township on the east, Mudon Township on the south and Chaungzon Township on the west. The study area is located (14.48) kilometres (9 miles) to the south of Mawlamyine urban area and close to Pa-Auk monastery, a well-known meditation centre. It also has University of Technology and it is fairly developed economically.

Mawlamyine Township is resided mostly by Bamars (57.5%), followed by Mon (20.32%). In 2019, it had a total household of 45,065 with a population of 229,520. The majority, 266,075 or 86 percent, lived in the urban area and 36,555 or 14 percent inhabited in the rural area and with a total household of 7,675. The number of population in the study area in 2019 was 8,428 which represented 23 percent of the rural population of Mawlamyine Township. The inhabitants are mostly Mons. The number of workforce in Mawlamyine Township was 169,455 of which 126,592 or 75 percent were engaged in certain jobs. The number of people with no employment was 42,863 or 25 percent of the total workforce. There were 102,928 dependents and the dependency ratio was 102,928/126,592*100=81(Source: GAD, Mawlamyine Township, 2019).

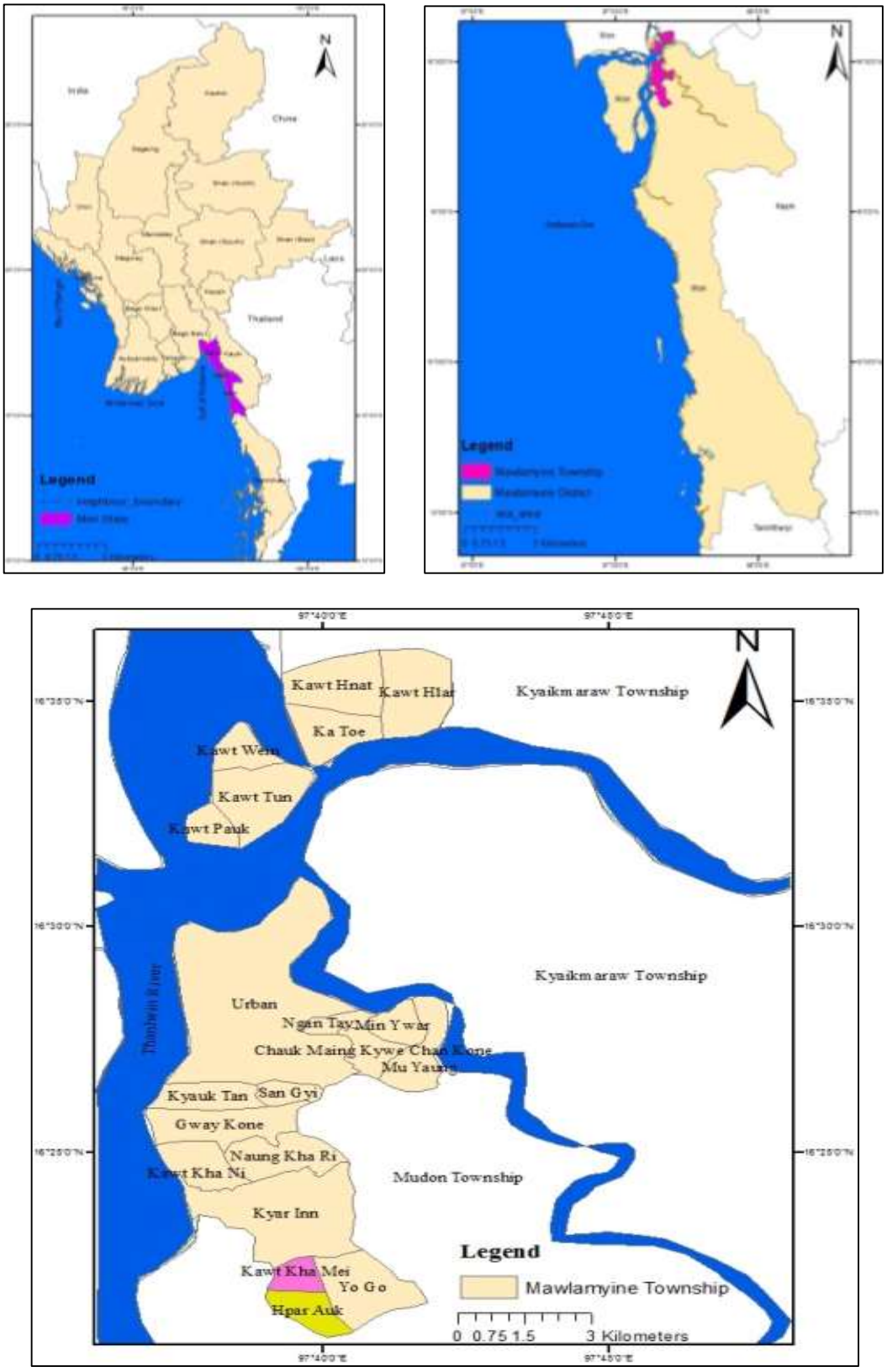


Figure 1 Location of study area in Mawlamyine Township

Findings

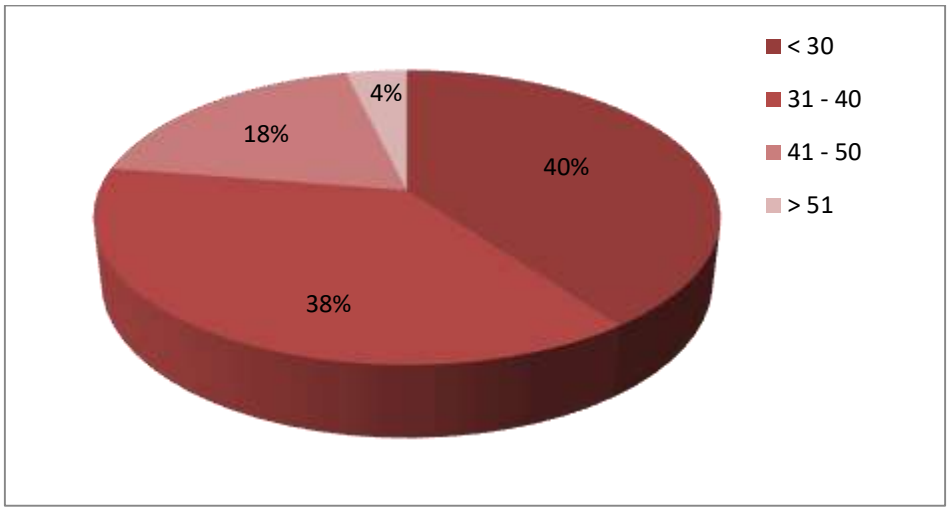
Socio-economic Characteristics of the Migrants

Gender

Of the 120 migrants workers under study 68 (57 percent) are males and the remaining 52 (43 percent) females. Therefore, there is less difference between two males and females among the migrant workers.

Age (years)

Among the 120 migrant workers, 48 (40 percent) are aged under 30 years, 45 (38 percent) between 31 and 40 years, 22 (18 percent) between 41 and 50 years and 5 (4 percent) 51 and above years. Generally young adults who can work manually are the most common among the migrant workers.



Source: Table 1

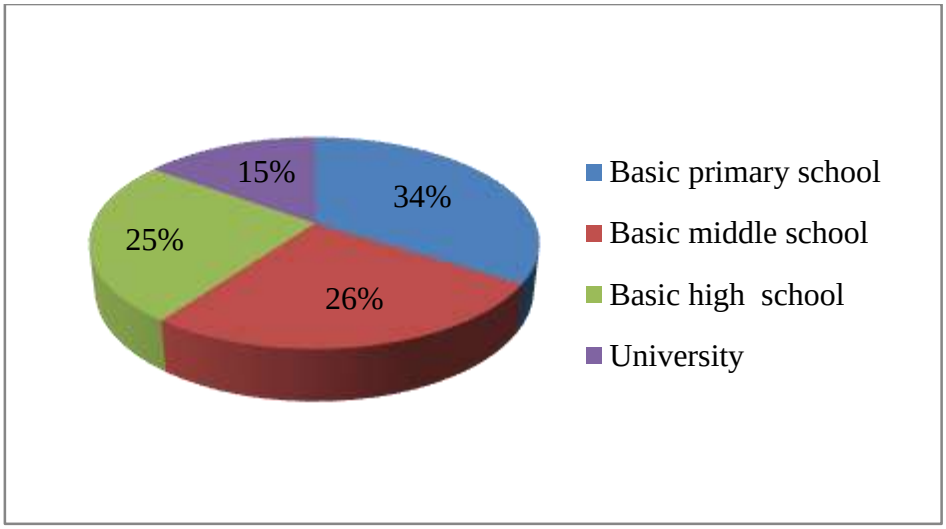
Figure 2 Age of the migrant workers in the study area

Marital Status

Migrant workers include both single and married. The married couples earn more income. Some couples have offsprings and they leave them with their grandmother and grandfather to look after the kids. Of the 120 migrants, 43 (36 percent) are single and 77 (64 percent) married. This shows that married migrants are greater in number than the single ones.

Education Status

As regards to the education level of the migrants, 41 (34 percent) are of basic primary level, 31 (26 percent) basic middle level, 30 (25 percent) basic high school level and 18 (15 percent) university level. Generally basic primary level and basic middle level are more common.

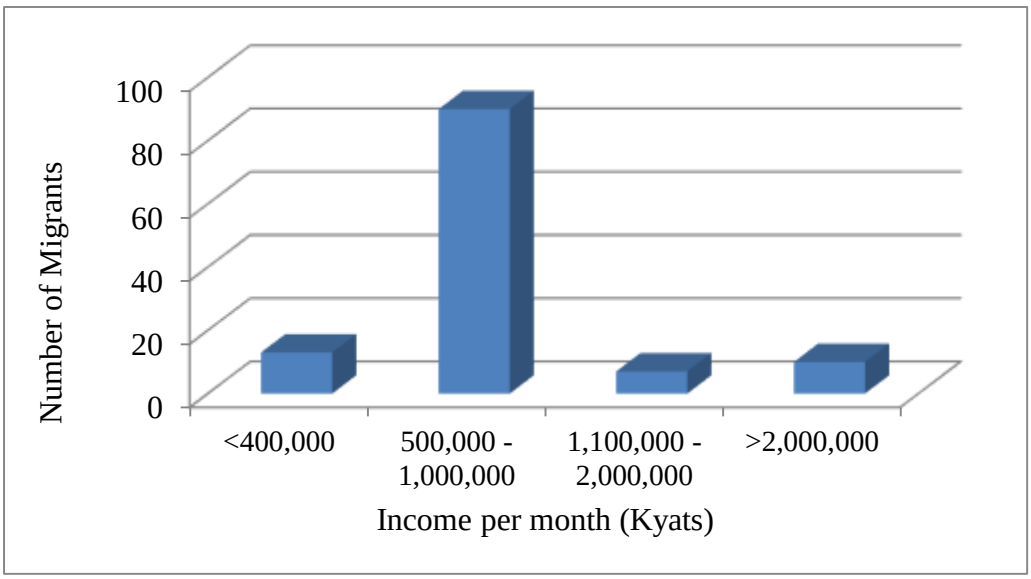


Source: Table 1

Figure 3 Education levels of the migrant workers in the study area

Income

According to questionnaire survey, 90 (75 percent) earn a monthly income of between kyats 5 and kyats 10 lakhs, while 13 (11 percent) receive kyats 4 lakhs each. There are 7 (6 percent) migrant workers who earn between kyats 11 and kyats 20 lakhs per month and 10 (8 percent) over 20 lakhs. Although their education level is low, they can earn a considerable high income in other countries, much higher than the salary earned by the gazette officer in the homeland. This is the main reason of leaving the country and work as migrant workers in other countries.



Source: Table 1

Figure 4 Income per month (Kyats) of the migrant workers in the destination area

Table 1 Distribution of migrant workers according to socio-economic characteristics (n= 120)

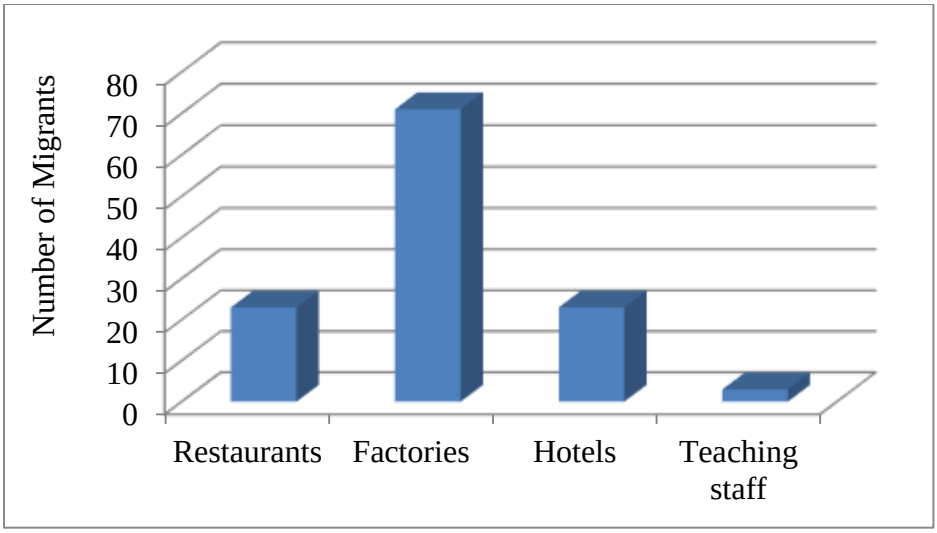
Socio-economics characteristics	Frequency	Percentage
Gender		
Male	68	57
Female	52	43
Total	120	100
Age (Years)		
< 30	48	40
31 - 40	45	38
41 - 50	22	18
> 51	5	4
Total	120	100
Marital Status		
Single	43	36
Married	77	64
Total	120	100
Education Status		
Basic primary school	41	34
Basic middle school	31	26
Basic high school	30	25
University	18	15
Total	120	100
Current Job Type		
Restaurants	23	19
Factories	71	59
Hotels	23	19
Teaching staff	3	3
Total	120	100
Former Job Type		
Student	9	8
Jobless	72	60
Trading activity	13	11
Traditional weaving activity	21	17
Transporting activity	5	4
Total	120	100
Income		
<400,000	13	11
500,000 - 1,000,000	90	75
1,100,000 - 2,000,000	7	6

Socio-economics characteristics	**Frequency**	**Percentage**
>2,000,000	10	8
Total	120	100
Types of house		
Brick house	66	55
Semi-brick house	39	33
Wooden house	15	12
Total	120	100
Migrant's Destination		
Thailand	95	79.17
Malaysia	10	8.33
Korea	10	8.33
Japan	5	4.17
Total	120	100
Reasons of migration		
Job opportunities in destination	120	100
Migration Time		
2000-2004	9	7
2005-2009	13	11
2010-2014	36	30
2015-2019	62	52
Total	120	100
Farm ownership (Acre)		
No Farmland	102	85
Own farmland	18	15
Total	120	100
Dependency Percentage		
Dependency Percentage	Number of Households	
No Dependent	4	
Below 50%	20	
Above 50%	96	
Total	120	

Source: Field observation (25/12/2019 – 6/1/2020)

Current Job Types

Among the migrant workers under study, 71 (59 percent) are engaged at factories, 23 (19 percent) each at restaurants and hotels and only 3 (3 percent) in service activity as teaching staff.

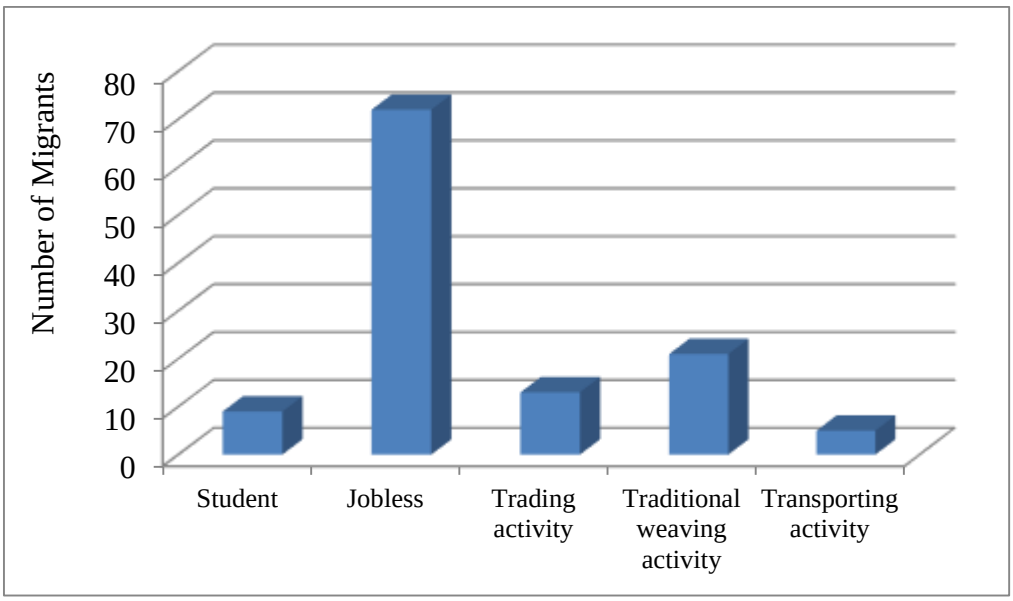


Source: Table 1

Figure 5 Current job types of the migrant workers in the destination area

Former Job Types

Before they left their homeland, 72 (60 percent) were jobless, depending on family income. Among the remainders, 21 (17 percent) were engaged in traditional weaving activity, 13 (11 percent) in trading activity, 9 (8 percent) in pursuing education and 5 (4 percent) in transporting activity.



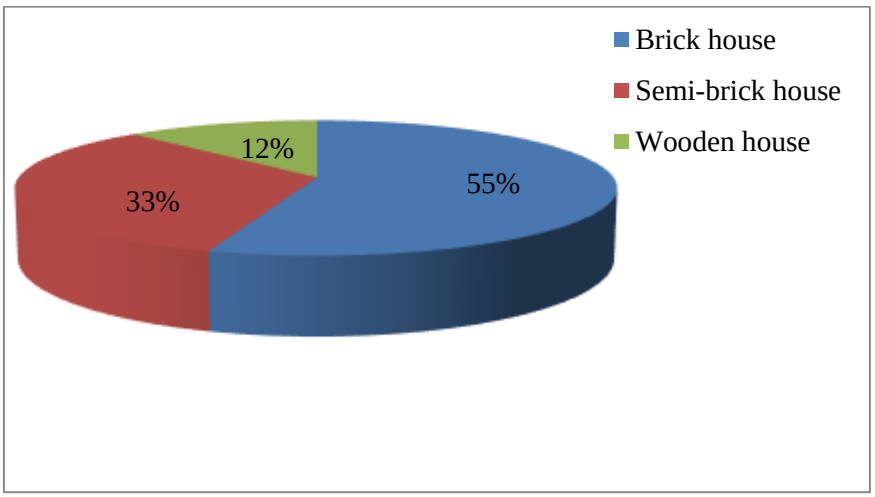
Source: Table 1

Figure 6 Former job types of the migrant workers in the study area

Types of House

Type of house is on of important indicators of the socioeconomic status of the house concerned. According to field surveys, there are 66 (55 percent) brick houses, 39 (33 percent) semi-brick houses and 15 (12 percent) wooden houses. Even the wooden houses are large with two

stories; this situation indicates that the socioeconomic status of the families of the migrant workers is moderately high.

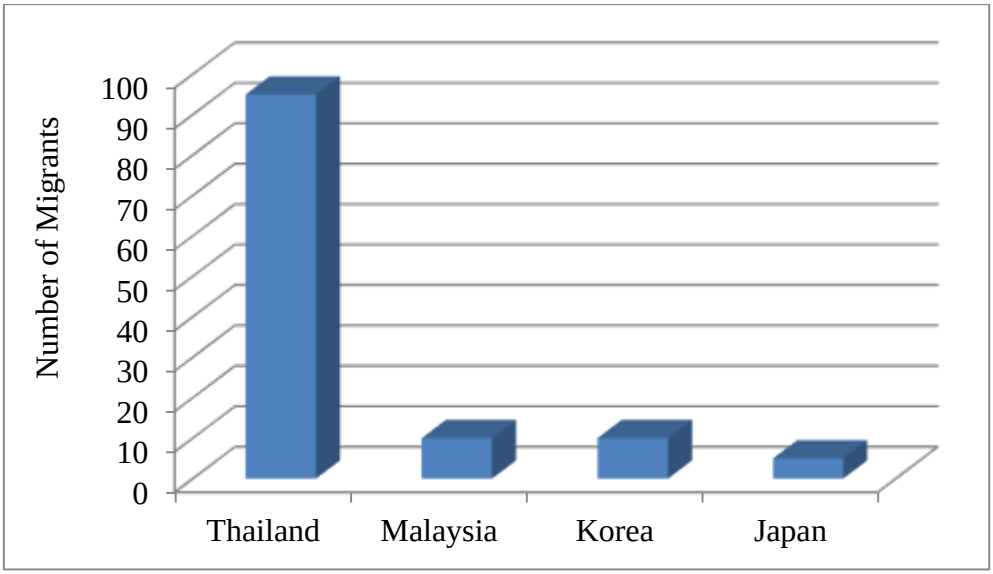


Source: Table 1

Figure7 Types of house of the migrant workers in the study area

Migrant's Destination

The great majority of migrants' destination is Thailand, one of the neighbouring states of Myanmar. Among the 120 migrant workers, 95 (79.17 percent) searched job in Thailand, 10 (8.33 percent) each in Malaysia and South Korea and 5 (4.17 percent) in Japan.



Source: Table 1

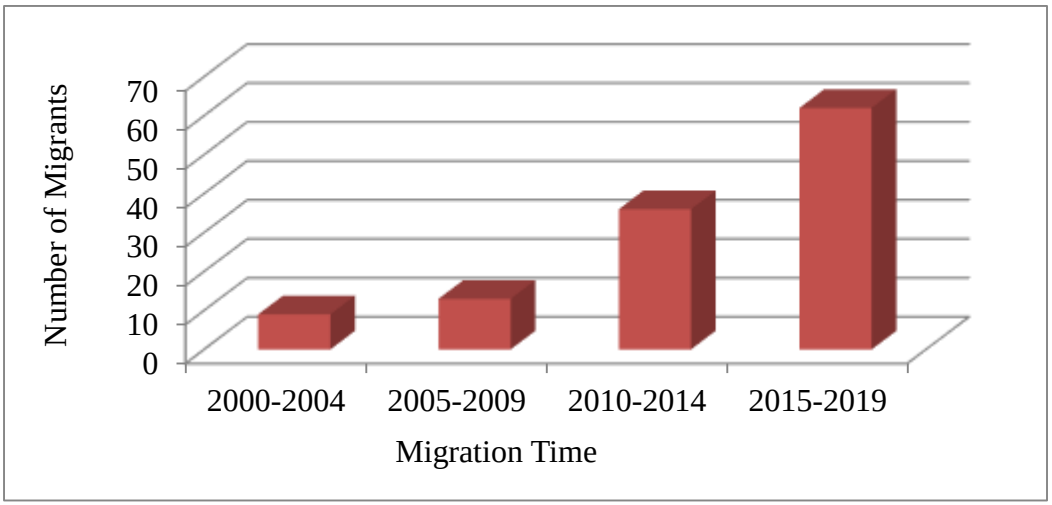
Figure 8 Destination or country of the migrant workers

Reasons of Migration

According to the responses to questionnaire survey, the main reasons of people leaving their native are due to low employment opportunity and low wage in the native land.

Migration Time

Based on the responses to questionnaire survey, the time spent in foreign countries as migrant workers is divided into 4 periods. In the 2000-2004 periods, there were only 9 (7 percent) migrant workers in the study area. The number of migrant workers was 13 (11 percent) in the 2005-2009 period, 36 (30 percent) in the 2010-2014 and 62 (52 percent) in the 2015-2019. This show that the number of people leaving the homeland to neighbouring and other countries for jobs that earns more income has been notably increasing. It was more than half of the total migrants in the last 5 years.



Source: Table 1

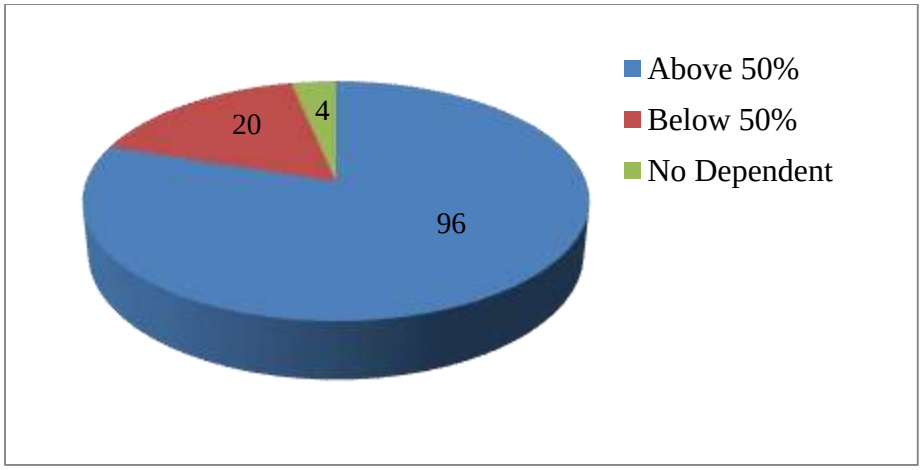
Figure 9 Migration time of the migrant's workers in the study area

Farm Ownership

Among the migrant workers' only 18 (15 percent) households have their own farmland and the remaining 102 (85 percent) are not get involved in the farmwork.

Dependency Percentage

According to questionnaire survey the majority of the members of the sample households depend on the remittance for their livelihood. There are only 4 households that do not depend on the remittance, but less than 50 percent of the 20 households members depend on it, while more than 50 percent of 96 households rely on the money sent back by the respective migrant workers. Therefore, the incomes gained by the migrant workers are very important for the livelihood of the household members and their socioeconomic status.



Source: Table 1

Figure 10 Dependency Percentage of the families on the remittance of the migrant workers in the study area

SWOT Analysis on the migration and its effects on the economics development of study area in Mawlamyine Township

Strength	**Weaknesses**
- widening of knowledge related to politics, economics, social and culture - more exposure and relation with the foreigners - exchange of ideas and outlook among the youths of the native and foreign worker	- leaving the aged and the youth in the native - scarcity of labour for farmwork - decline in the traditional weaving industry - leaving some parts of the farmland uncultivated - the growth up of offsprings without the care of parents - living together only with grandmother and grandfather
Opportunities	**Threats**
- the increase of remittance, hence more foreign exchange for the country - the increase in the annual income of households - being able to go foreign countries easily, especially to Thailand - the progress of socioeconomic status - increase in the number of skilled labourers - being able to start business with the experiences gained from other countries (e.g. Htai cuisine shop, made-up and hair-beauty saloon)	- the decrease in the number of workforce - brain drain - replacement of Thai food - rapid spread of foreign culture (e.g clothing pattern, hair style, wearing of ear-ring by young males)

Source: Own idea based on field observation and interview (20/12/2019 – 30/12/2019)

Discussion and Conclusion

This paper analyzes migration and its effects on the economic condition in Pa-Auk and Kawt Kha Mel Village Tracts, Mawlamyine Township, Mon State. In the study area, all households have one or more migrant workers. The number of migrants at basic education level is higher than those at University Level as they moved before they finished their education. Most of the migrants are below the age of 51 years. Many young people are advantages in nature that they migrate to other countries. And a large variety of them work at the factory. According to the marital status, the number of married migrants is greater than singles. From the results of the interviews, there are 18 couples among 77 married migrants. Hence, almost the half of married people are found to be couples. Their previous job history is asked and most of the migrant workers were jobless before migrant, which is the main reason for their movement. Many female migrants workers had worked at traditional weaving and their salaries were low. Therefore, they moved to other countries for work. The income was raised after migration that they are able to reconstruct their houses and support their families. As a result, a lot of new and still constructing houses can be found in the study area. The migration to Thailand is more than migrants to Malaysia, South Korea and Japan. It is because of the Distance Bias in the geographical point of view. Moreover, there is no limitation of travel to Thailand most of the migrants are already familiar with the place, culture and language. There are 96 (80 percent) out of 120 households that over 50 percent of the members depend on the remittance of the migrant workers. The amount of remittance sent back has been fairly large, leading to the increase in the household income, high in socioeconomic status, becoming skillful workers through experience, and starting own business by some. Such advantageous conditions will support to create better job when they come back to their native. On the other hand, earning income in foreign countries as migrant workers has such negative impact as shortage of labour in the homeland, the effect of brain drain and the influence of foreign cultures among the local communities.

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GEOGRAPHIC ASSESSMENT ON DEMOGRAPHIC CONDITIONS OF MAGWAY REGION: A CASE STUDY OF INFANT MORTALITY

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Abstract

Infant mortality is defined as the number of deaths of children under one year of age per 1,000 live births. It is widely accepted as an important indicator of the health of the country's population. According to 2014 Myanmar Population and Housing Census, Magway Region has a relatively highest infant mortality rate (IMR) compared with other states and regions of Myanmar. The aim of this paper is to do geographic assessment on high infant mortality of research area. The present paper attempted to investigate using data from household survey. This study emphasizes on spatial patterns of infant mortality in Magway Region by applying qualitative method after conducting questionnaire survey on highest infant mortality area using factorial discriminate analysis. Spatial analysis was employed to explore spatial distribution and temporal variation of infant mortality in the Magway Region. Result of this study show that the environmental and geographical characteristics of the study area are strongly influence on infant mortality.

Keywords: Infant mortality, qualitative method, questionnaire survey, spatial analysis, spatial distribution, temporal variation

Introduction

The infant mortality rate is an important marker of the overall health of a society. High infant mortality rates are generally indicative of unmet human health needs in sanitation, medical care, nutrition, and education (www.britannica.com/science). Infant mortality rate in Geography means the number of deaths under one year of age occurring among the live births in a given geographical area during a given year, per 1,000 live births occurring among the population of the given geographical area during the same year (www.stats.oecd.org/glossary). According to the 2014 Myanmar Population and Housing Census Report, Magway Region is highest in infant mortality rate (89) and the lowest is Mon State (43) in Myanmar (Figure 1). Therefore, this study examines spatial distribution of infant mortality rate (IMR) of Magway Region. Geographically, infant mortality rates in 2014 were highest among townships particularly in Myaing, Natmauk and Ngaphe in this region (http://www.dop.gov.mm). Among them, the highest mortality rate is found in Myaing Township within ten-year study period (2010 to 2019).

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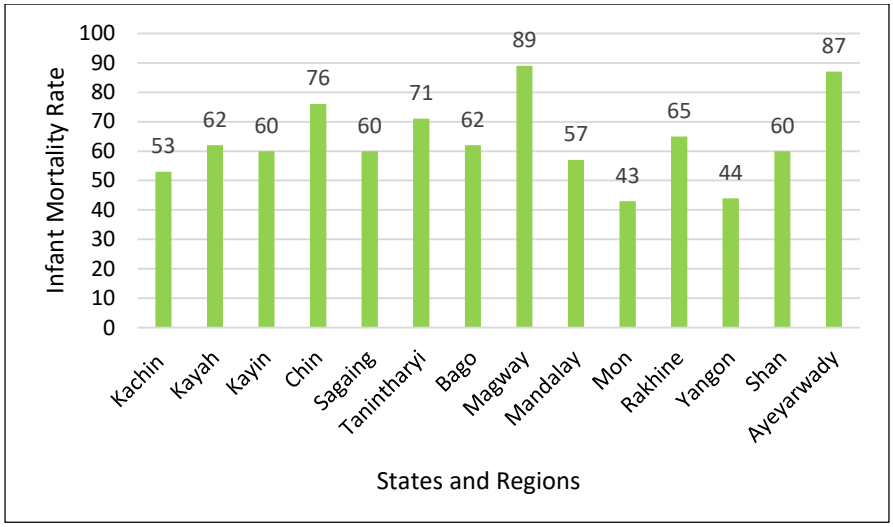


Source: 2014 Myanmar population and housing census report.

Figure 1 Infant mortality rate in States and Regions of Myanmar.

Study Area

Magway Region is located between north latitudes 18° 50' and 22° 47' and between east latitudes 93° 47' and 95° 55'. It is bounded by Rakhine and Chin States on the west, Sagaing Region on the north, Mandalay Region on the east and Bago Region on the south. Magway Region is composed of 5 districts with 25 townships (Figure 2).

Aim and Objectives

The aim of this paper is to do geographic assessment on high infant mortality of the research area. To achieve the aim of study, the specific objectives are to investigate the spatial distribution pattern of infant mortality in Magway Region, to examine the temporal variation of infant mortality in research area, to identify the causes of infant mortality and to assess the relationship between highest infant mortality and geographical, socio-economic and environmental factors of research area.

Materials and Methods

In acquiring primary data, field observation was undertaken and questionnaires were prepared according to purposive sampling design. Myaing Township was chosen among the townships due to highest infant mortality rate within Magway Region and conducted the questionnaire survey by using factorial discriminate analysis. The sample size (number of questionnaires) was 30 percent of the target population. Data collection about the demographic, social, economic, health, education and environmental factors and expert interviews took place during 2019 in which 437 questionnaires were distributed and collected to households.

Secondary data were collected from Administrative Department, Immigration and National Registration Department, Township and Regional Hospital and Health Departments in Magway Region. To calculate infant mortality rate (IMR) of research area, following formula was used. In this formula, the ratio of infant deaths registered in a given year to the total number of live births registered in the same year; usually expressed as a rate per 1,000 live births (www.britannica.com/science/infant-mortality-rate).

$$\text{IMR} = \frac{\text{Number of deaths of children less than one year of age in a year}}{\text{Number of live births in the same year}} \times 1{,}000$$

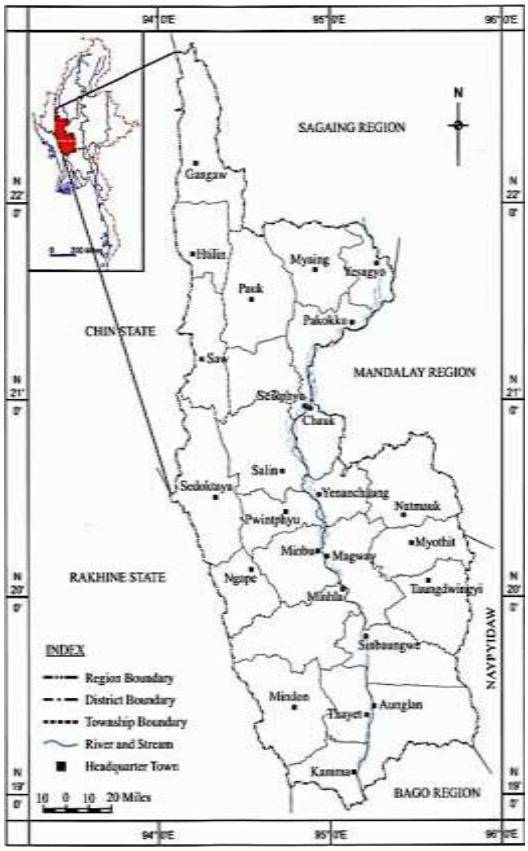
Basic Geographical Factors of Research Area

Physical Factors

Magway Region is situated in the Dry Zone of Central Myanmar. The Region has an area of 44819.74 square kilometers (17,305 square miles) and its capital is Magway. Topographically, Magway Region is located in lowland region but the western portion is occupied by higher mountain ranges and the spurs of Bago Yoma in the eastern part. The physical feature of Magway Region is divided into four units. They are the western mountain ranges, the western undulating land, the Ayeyarwady-Chindwin River basin and the eastern undulating upland (Figure 3).

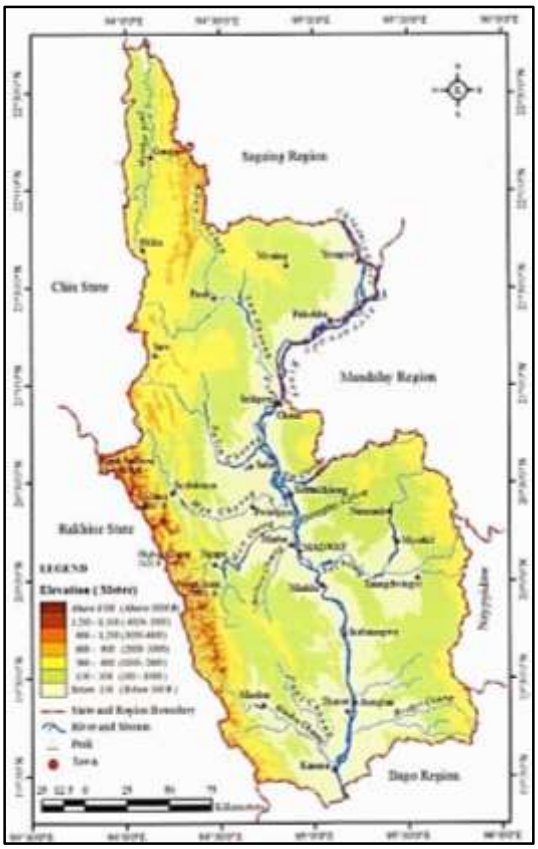
Magway Region is generally low-lying along the Ayeyarwady, the main river of Magway Region. The eastern tributaries of the Ayeyarwady River are Pin, Yin, Daungthay and Bwetgyi Streams. Tributaries entering the Ayeyarwady from the west are Yaw, Salin, Mone, Mann and Mindone Streams. Lakes and inns are found in the flooded area of Ayeyarwady River. Dams are built in the Magway Region and they are important sources of water for irrigation.

Magway Region falls within the tropical zone and experiences tropical monsoon climate. According to Koppen's climatic classification, climate is classified into three types: Tropical steppe climate, Tropical savanna climate and Subtropical monsoon climate. Except Aunglan and Kamma Townships, tropical steppe climate is found in the remaining townships in the central valley of Magway Region. Tropical savanna climate is found outside the tropical steppe climate belt in Magway Region. The subtropical monsoon climate is found in western mountain ranges of Magway Region and parts of Saw, Saytoketayar, Ngaphae, Minhla, Mindone and Kanma Townships. According to the meteorological records during 25 years period from 1995-2019, the average maximum temperature was 37.36° C (99.24° F), the average minimum temperature 17.69° C (63.84° F) and the mean temperature has 27.58° C (81.64° F). April is the hottest month with 43.84° C (110.91° F) and January is the coldest month with 9.44° C (48.99° F). According to the rainfall data from 1995 to 2019, the yearly rainfall of Magway Region is not different significantly; it is always between 20 inches and 40 inches.



Source: Agricultural Land Management and Statistics Department, Magway Region

Figure 2 Location Map of Magway Region

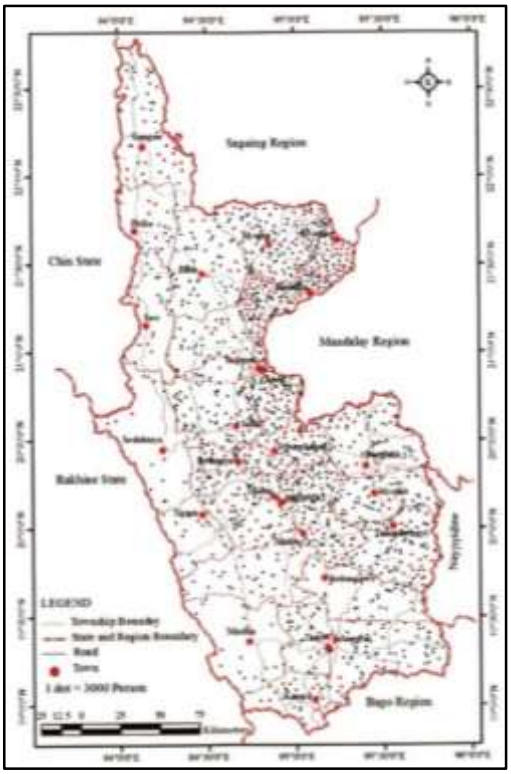


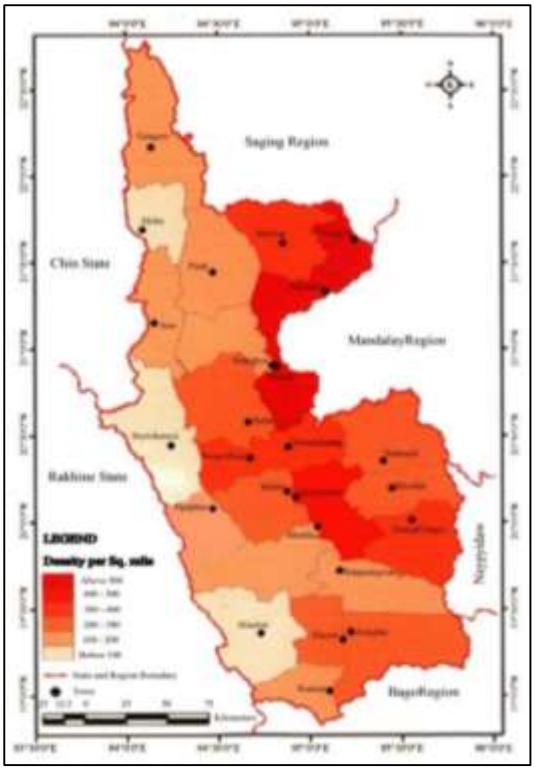
Source: Elevation Extract from Digital Elevation Model (SRTM DEM 90 Meter)

Figure 3 Relief and Drainage of Magway Region

Social Factors

Infant mortality rate of the study area is largely influenced by the social factors. Population is the most important factor regarding the outbreak of diseases and also high infant mortality rate. Magway Region is a populated area with total population was 2,632,144 persons in census year 1973. It increased to 4,167,615 persons in 2019. In 1973, population density of Magway Region was 152 persons per square mile and it increased to 241 persons per square mile in 2019. According to population data, Pakokku Township was highest number of populations with 300,689 persons and density was 660 persons per square mile. The second highest populated area is Magway Township having 284,848 persons and density was 431 persons per square mile. Saytoketayar Township has the lowest number of populations with 43,855 persons and population density has only 41 persons per square mile (Figure 4, 5, 6).

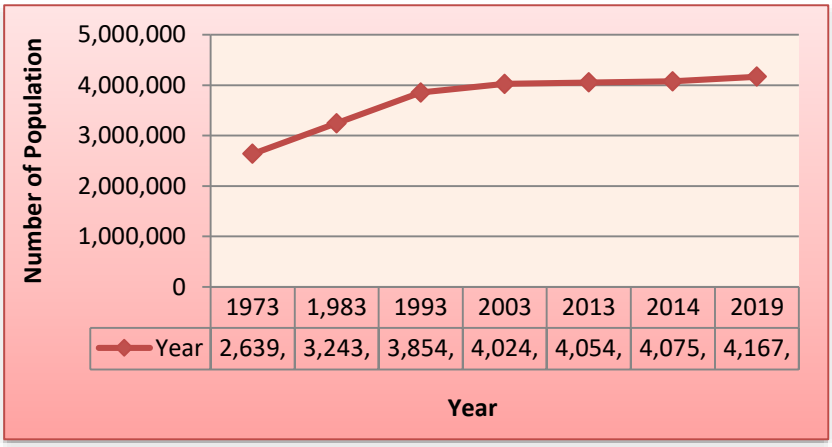




Source: Immigration and National Registration Department, Magway Region

Figure 4 Population Distribution of Magway Region (2019)

Figure 5 Population Density of Magway Region (2019)



Source: Immigration and National Registration Department, Magway Region

Figure 6 Population Growth of Magway Region (1973-2019)

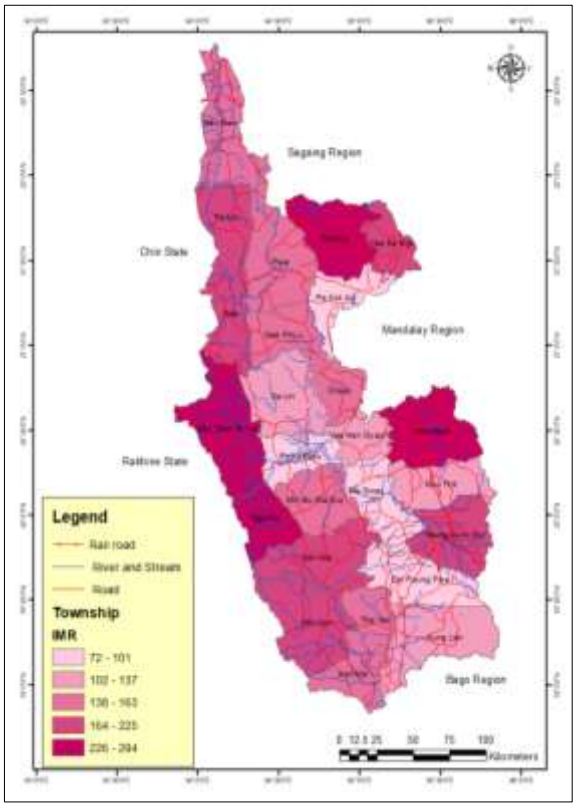
Results and Findings

According to the results of field surveys, household questionnaires and secondary data from regional health department in the study area, infant mortality rate was highest in Myaing Township and lowest infant mortality rate were found in Htilin and Pakokku townships within ten years study period (2010 to 2019) in Magway Region (Table 1 and 2).

Spatial Distribution of Infant Mortality

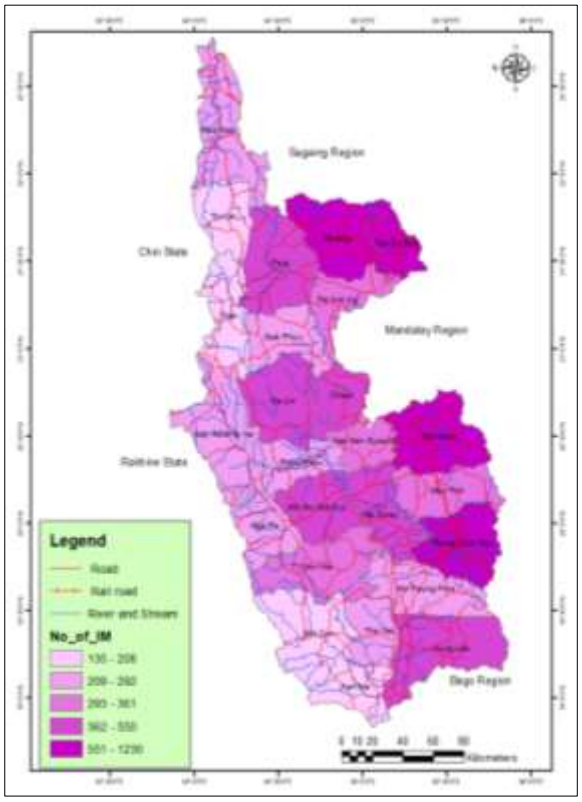
The spatial analysis on high Infant Mortality Rate (IMR) was worked out by using questionnaires and interview. The data were collected by applying questionnaires was conducted to various sample household in study area. Currently highest infant mortality within ten years is in Myaing Township and the lowest in Htilin Township.

According to the calculated results of infant mortality rate, high IMR was found in Myaing and Natmauk Townships located in the eastern part and Saytoketayar and Ngaphae townships in the western part of Magway Region. And also, high number of infant mortalities was found in Myaing and Yaesagyo Townships in northeastern part and Natmauk and Taungdwingyi Townships in the southeastern part of Magway Region (Figure 7 and 8).



Source: Based on Table 1

Figure 7 Spatial distribution of infant mortality rate in Magway Region (2010-2019)



Source: Based on Table 2

Figure 8 Spatial distribution of number of infant mortality in Magway Region (2010-2019)

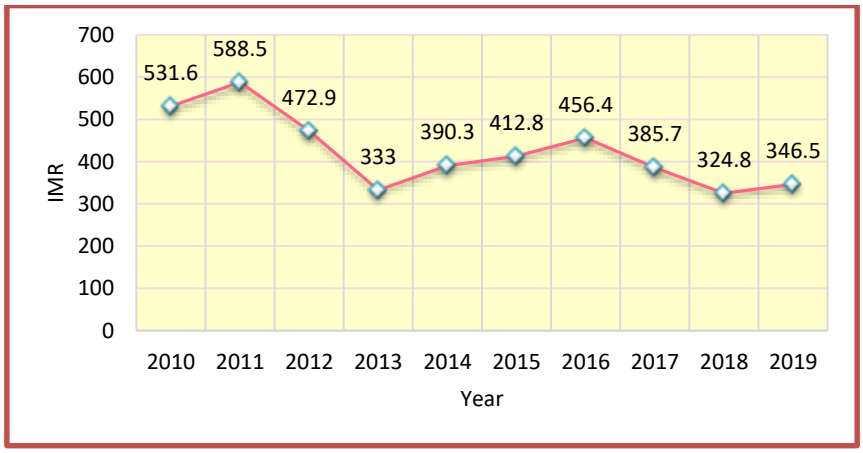
Temporal Variation of Infant Mortality

During the study period from 2010 to 2019, highest infant mortality rate was 588.3 in 2011 and the lowest rate is 333 in 2013. Number of infant mortalities within ten years has the highest is 1,548 in 2010 and the lowest is 777 in 2018 (Figure 9 and 10). In the study area, this high infant mortality is due to some of the seasonal diseases such acute respiratory infection (ARI), dengue hemorrhagic fever (DHF), heart disease, etc. in the year 2010-11. The trend of infant mortality in Magway Region generally decreases from 2010 to the present.

Table 1 Infant mortality rate of townships in Magway Region (2010 to 2019)

Sr. No.	Township	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Magway	9.8	10	14.3	5.9	11.9	10.3	13.6	10.5	8	7
2	Chauk	21	15	7.9	11.4	15.4	14.5	24.6	19.2	7.7	11.2
3	Taungdwingyi	28.5	26.3	20.7	14	18.8	27.3	28.9	15.6	12	11.5
4	Natmauk	31.5	32.9	34.1	26.3	42	29.8	20.9	16.7	12.3	7.5
5	Myoethit	14	12.3	6.6	3.2	4.6	11.3	13.2	11.9	14.9	20.5
6	Yenachaung	11	17.3	10.8	3.7	11.1	14.9	20	12.1	14.3	13
7	Minbu	24.2	28.2	25.6	12.3	7.8	13.3	15	11	14.4	11
8	Ngaphae	33	41	28.1	21.9	28.2	18.8	30.7	23.1	23.4	19.5
9	Salin	20	16.4	8.2	5.3	7.1	7.2	10.6	10.1	13.9	12.9
10	Saytoketayar	43.6	39.7	21.5	15.5	22.3	27	34.4	20.5	25.3	23.6
11	Pwintphyu	14.1	7	8.9	6	4.8	7	12.8	10.2	4.3	5.2
12	**Pakokku**	8.7	9.5	7.2	2.2	1.5	2	9.3	10.8	8.9	12.2
13	Seikphyu	20.7	15.7	9.6	4.6	8.6	8.9	20.1	31.9	14.2	23.2
14	Pauk	17.3	15.9	16.7	22.2	8.5	17.7	19.8	10.1	10	14.4
15	**Myaing**	27.2	49	60.3	26.1	33.5	24.2	21	24.1	14.4	14.3
16	Yesagyo	28	28.4	30.8	19.4	19.4	19.2	17.2	11.4	14.5	15.3
17	Gantgaw	24.6	17.9	9.4	5.8	5.8	8.9	13.8	18.1	19.9	16.3
18	Saw	27.2	31.7	25.2	24.9	20.8	15	23	17	17	13
19	Htilin	12.8	22.9	28.2	9.7	18.1	25.1	17.7	23	13.1	24.5
20	Thayet	11.6	35	9.4	14	19.7	18.8	25.2	10	7.2	7.8
21	Kanma	9.3	7.1	15.4	18	25.9	24.7	8.5	14.7	17.7	22
22	Sinpaungwae	20.4	15	13.5	6.8	6.1	8.7	11.6	2.7	4.7	2.1
23	Mintone	34.3	46.9	18.8	26.8	9.7	19.8	23.3	19.3	9.8	16.5
24	Minhla	22.8	35.4	22.3	7.6	25	27	9.7	21.7	11.3	10.3
25	Aunglan	16	12	19.4	19.4	13.7	11.4	11.5	10	11.6	11.7
	Total	531.6	**588.5**	472.9	**333**	390.3	412.8	456.4	385.7	324.8	346.5

Source: Regional Health Department, Magway Region.



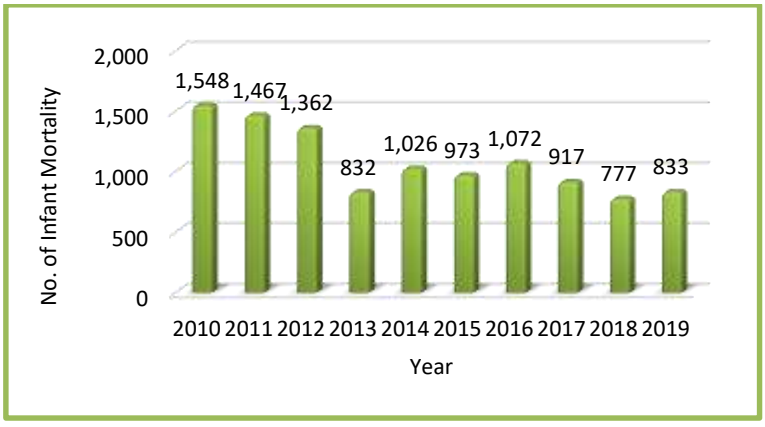
Source: Based on Table 1

Figure 9 Temporal variation of Infant Mortality Rate (IMR) in Magway Region (2010-2019)

Table 2 The number of infant mortality in townships of Magway Region (2010 to 2019)

Sr. No.	Township	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
1	Magway	44	47	75	31	59	45	59	48	37	33	478
2	Chauk	91	64	34	47	53	50	82	67	26	36	550
3	Taungdwingyi	158	133	106	85	101	115	127	66	52	53	996
4	Natmauk	125	125	126	96	168	109	79	62	49	29	968
5	Myoethit	43	35	19	9	14	31	32	31	45	61	320
6	Yenachaung	31	58	45	16	36	38	41	25	31	31	352
7	Minbu	71	84	87	40	26	37	40	33	41	31	490
8	Ngaphae	36	45	31	32	28	18	28	22	21	16	277
9	Salin	85	67	35	23	30	26	36	40	55	58	455
10	Saytoketayar	42	35	19	12	18	21	25	14	17	16	219
11	Pwintphyu	39	23	26	18	14	18	33	26	12	13	222
12	Pakokku	49	42	31	11	8	10	49	54	46	61	361
13	Seikphyu	46	24	17	8	17	16	35	58	24	41	286
14	Pauk	57	50	51	35	26	56	60	34	34	46	449
15	**Myaing**	174	163	258	101	133	97	85	101	59	59	**1,230**
16	Yesagyo	108	115	119	76	83	72	65	45	56	62	801
17	Gantgaw	48	37	19	10	11	17	29	40	44	37	292
18	Saw	29	31	26	24	19	13	20	15	16	15	208
19	**Htilin**	10	23	20	7	12	16	11	14	8	14	**135**
20	Thayet	40	64	20	16	27	26	35	13	10	9	260
21	Kanma	18	11	17	18	28	24	8	14	18	21	177
22	Sinpaungwae	72	40	35	12	12	15	21	5	9	18	239
23	Mintone	25	27	14	18	7	15	16	14	7	13	156
24	Minhla	35	62	40	12	43	48	18	41	21	18	338
25	Aunglan	72	62	92	75	53	40	38	35	39	42	548
	Total	**1,548**	1,467	1,362	832	1,026	973	1,072	917	**777**	833	10,807

Source: Regional Health Department, Magway Region



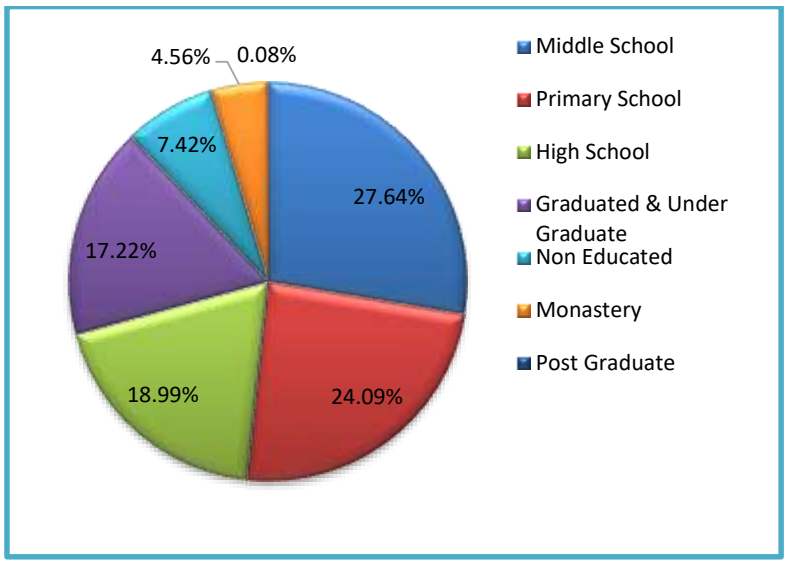
Source: Based on Table 2

Figure 10 Temporal variation of number of infant mortality in Magway Region (2010-2019)

Factors Causing High Infant Mortality

The results of household questionnaire survey in 2019, shows that socio-economic status of the household and environmental factors, such as mother's educational level and head of the household, occupation conditions, health knowledge, condition of house type, household's access to drinking water and water utilization, sanitation facilities as type of toilet, waste disposal, and environmental awareness, etc. are major factors causing high infant mortality in study area.

Low education level with limited knowledge and information reflects the high incidences of infant mortality (www.britannica.com/science). Health knowledge is limited to the local people due to low level of education and a few people have no health knowledge. According to the results of questionnaire and interview in 2019, 27.64 percent of household head is middle school level, 24.09 percent is primary school level and 0.08 percent is post graduate level in education (Figure 11).



Source: Result of questionnaires and field survey, 2019.

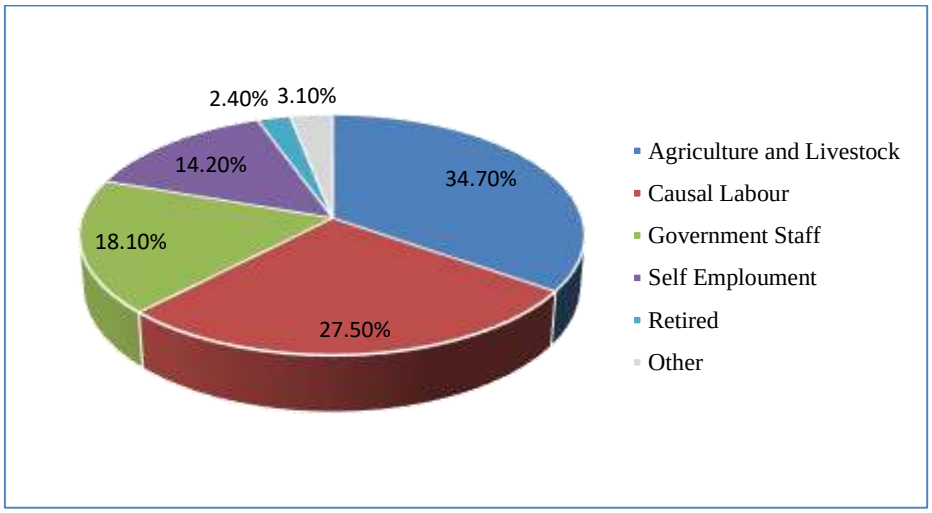
Figure 11 Educational level of household head in study area.

About 63 percent of the respondent families use water from ponds, 30 percent from tube-well and 7 percent from surface wells. The majority of inhabitants use poor quality water. Most households store rain water in their house compounds for whole year-round consumption. Plate 1 shows the condition of drinking water sources in Myaing Township.

In occupation, 34.7 percent of the people are engaged in agriculture and livestock, 27.5 percent earn as causal labourers and 18.1 percent are government employees. Some retired persons also live in this study area. Another occupation are self-employment and others. (Figure 12).

Source: Field Survey, 2019

Plate 1: Drinking water pond and water storage in the study area.

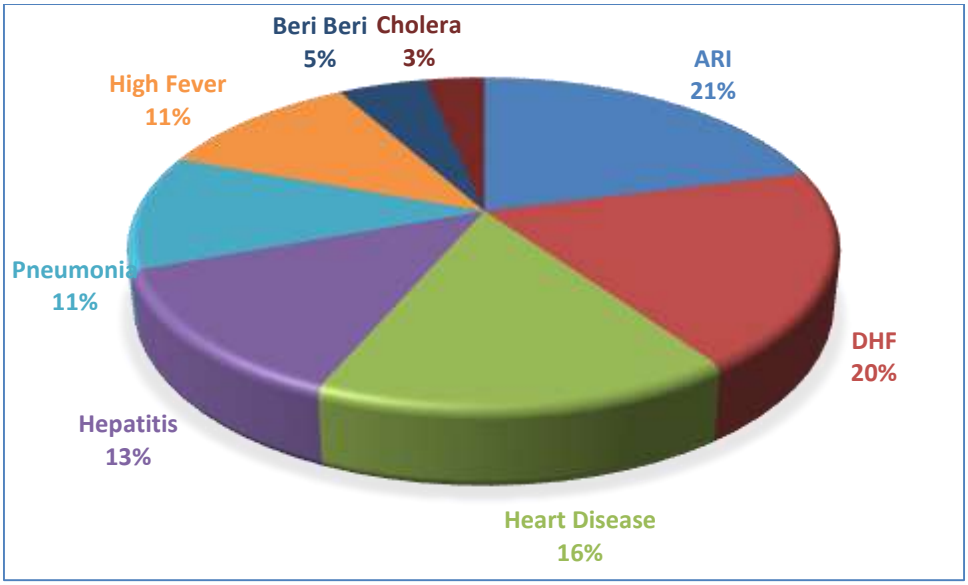


Source: Results of questionnaires and field survey, 2019.

Figure 12 Occupation of sample household member.

Local people encounter blocking of seasonal creeks during the rainy season. Therefore, difficulty for local people to go to hospital during the time of emergency. It is one of the factors for high mortality (Plate 2). According to their traditional habits, some families collect drinking water from ponds and store the tank in their house compound whole year round. It also affects health for their families. Most of the people do not want to go to the clinic, hospital, etc. when they suffer from ill health and it causes high infant mortality.

Some infected infant diseases is acute respiratory infection (ARI- 21%), dengue hemorrhagic fever (DHF- 20%), heart disease (16%), hepatitis (13%) pneumonia (11%), high fever (11%) etc. (Figure 13). DHF occurs when a mosquito carrying the arbovirus bites a human. Children especially between 1 to 14-year-old suffer from DHF. The incidence of respiratory disease ARI was caused due to cigarette smoking. Smokers can give negative effects on family member specially to infant as passive smokers. Moreover, the use of fuel wood and charcoals for cooking fuel at their home are also a factor causing respiratory disease. Smoke emission from their kitchen can cause air pollution and the number of infant deaths increases due to the respiratory disease (www.mayoclinec.com/health/dengue-fever).



Source: Results of questionnaires and field survey, 2019.

Figure 13 Diseases affecting infant mortality in study area.

Another factor causing high infant mortality rate is insufficient health staff for the township's population. One of the staff from Rural Health Care Center (RHC) takes responsible for health care services for people living in more than 3 villages. Table 3 shows the ratio of health staff and the number of populations in these townships and it causes high infant mortality in this study area. The ratio of health staff and population in Htilin Township is 1:512 and that of Myaing Township 1:1574 respectively. It is one of the evidences for high infant mortality in this study area.

Table 3 Health Staff and Population of Myaing and Htilin Townships.

Name of Township	Health Staff	No. of Population	Health Staff : No. of Population
Myaing	173	272,324	1: 1574
Htilin	98	50,168	1: 512

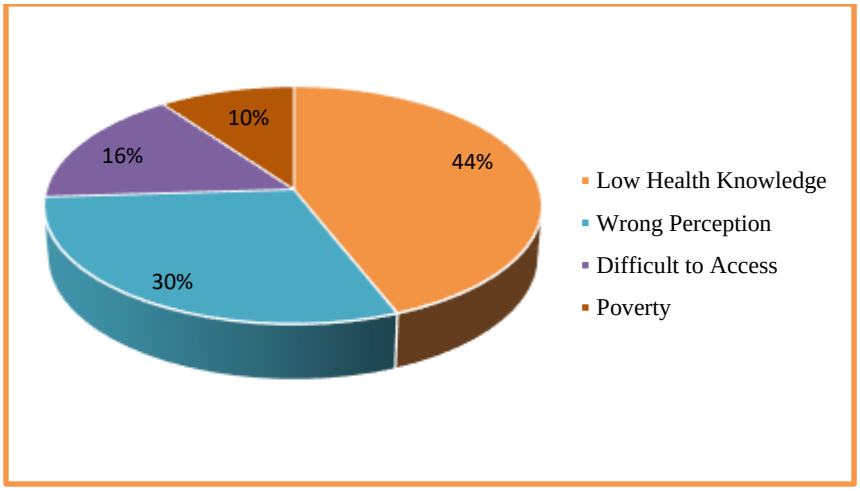
Source: Regional Health Department, Magway Region

Source: Field Survey, 2019

Plate 2: Seasonal creeks in the study area.

Discussion

Infant mortality is defined as the number of deaths of children under one year of age per 1,000 live births (www.stats.oecd.org/glossary/detail). It is widely accepted as an important indicator of the health of the country's population. According to the result of questionnaire survey, high infant mortality rate is related to low health knowledge (44 percent), low education level with high rate of illiterates, wrong perception (30 percent), the difficulties of transport especially in rainy season (16 percent) and insufficient of health care services poverty (10 percent) and low hygienic environment (Figure 14).



Source: Result of Questionnaire and Field Survey, 2019.

Figure 14 Factors causing infant mortality in study area.

In the study area, chief causes of diseases are almost directly related to health knowledge and awareness of local people. Medical staffs of the township's health care centres should do coordination with NGOs and launch educative talks to the local inhabitants particularly low-income families. Townships with high infant mortality in research area should be adopted as hot spot for health care services and health campaign should also be done. Therefore, these areas should be given as priority and not only for the effective treatment but also for the development of awareness on health issues should be carried out.

Magway Region is located in the Dry Zone of Central Myanmar, it received tropical climate and the amount of rainfall is less than other areas. The diseases causing infant mortality are found due to high temperature, low rainfall, crowded population and low-level awareness on health of the local people. Social factors, educational status, socio-economic factors, living style (living standard), health facility (favorable health care center), drinking water and domestic water use, basic sanitation, transportation and communication facility are the factors causing high infant mortality in the study area.

Conclusion

According to the result of study, spatial distribution pattern of infant mortality varies spatially from one place to another. The temporal variation of infant mortality was gradually decreased in ten year study periods in Magway Region. It is a good indicator for infant health and also demographic conditions of the research area. The result from household survey, common diseases affected to the infant are high fever, acute respiratory infections (ARI) and dengue hemorrhagic fever (DHF), pneumonia, heart disease, and hepatitis, etc. These diseases are major causes of high infant mortality rate (IMR) in this study area.

This paper presents the spatial analysis on infant mortality from the geographical point of view, expresses the various diseases effected to infant and high infant mortality rate relating to geographical factors, socio-economic, environmental and demographic conditions. Low education level is associated with high incidence of infant mortality rate. Therefore, socio-economic conditions should be promoted by providing the essential infrastructural bases like transportation, education, poverty reduction, health care facility, fresh water facility, high medical awareness level and effective treatment programs for the purpose of reducing infant mortality rate. Some rural health care center (RHC) and Sub-RHC are now working medical services not only for their adopted areas but for other settlements from nearby areas.

Human health especially infant health is important for sustainable development of the region. Since without good health, human beings would not be able to engage in development, combat poverty or care for their environment. Health knowledge and education should be promoted for the local people in this study area. In turn, caring environment is essential for human well-being and the development process of local people. A healthy environment leads to a healthy population and healthy life which will eventually lead to the reduction of infant mortality.

Acknowledgements

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ASSESSING ON DECLINING TRADITIONAL MANUFACTURING INDUSTRIES OF CHAUNGZON TOWNSHIP: A CASE STUDY OF SLATE AND SLATE PENCILS INDUSTRY AND PIPE INDUSTRY

Khin Khin Moe[1], Myint Thida[2], Nanda Khin [3], Nyunt Nyunt Than[4], Khin Su Kyaw[5]

Abstract

In Chaungzon Township, various manufacturing activities such as pipes, walking sticks, bamboo products, slate and slate pencils, rubber rings and other handicraft industries are found. Among them, slate and slate pencils, and pipe produce unique local traditional products that have cultural value. But, the traditional product work decrease in production and significance due to changing market demand, raw material availability, technology improvement, etc. To present traditional, manufacturing industries particularly production of slate and slate pencils industry and pipe industry, Chaungzon Township was selected as study area. The products of manufacturing activities of Mudu village tract and Ywalut village tract are not only used for local areas but also exported to other regions.Then, present situation, problems and future prospects of were presented. Some manufacturing activities such as pipe industries, walking stick industries and slate and slate pencils industries are found to be in slow progress in study area. This is due to the shortage of skilled labours, decrease of market demand and insufficiency of capital.

Keywords: manufacturing activities, pipe industries, slate, slate pencils, walking stick

Introduction

Chuta & Allal, 1982, said that the local traditional product production plays an important role in income and work opportunity and it also been accepted worldwide as a mean for poverty reduction. Leesuwan, 2010, then, mentioned that the local products lost its role because industrial products flourished due to better quality, beautiful design and high demand. Yang et al, 2018, also wrote that traditional products reflect the culture and tradition of a particular region.

In most countries, local traditional product and craft production decline in certain extent due to technology improvement, low market demand, low economic return, etc. Local traditional product cannot compete modern products that have high quality and are more beautiful although local traditional product has intangible cultural value.

Objectives of the paper are:

- To examine present traditional manufacturing industries of Mudu village and Ywalut village tracts.
- To explore the major requirements to improve the production of local traditional products
- To understand the declining of traditional manufacturing industries in the study area
- To predict future prospects on local traditional products production

Methodology

The research work was based on primary data and secondary data. Primary data are collected through field observation and semi-structure interviews. Primary data are mainly

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concerned with major requirements for traditional manufacturing industries, present and past situation, problems encountered by labour and owners, etc. In Mudu Village Tract, 3 owners and 3 labour of slate and slate pencils were interviewed and 3 owners and 3 labour of pipe industries in Ywalut Village Tract.

Secondary data were obtained from departments concerned. Key informants who experience more than 40 years were interviewed to get in-depth understanding on traditional manufacturing industries of Chaungzon Township. To present the research work, exploratory approach was used. To present the paper, geographical techniques were applied and Geographic Information System tools are used to portray traditional manufacturing industries in Chaungzon Township.

Study Area

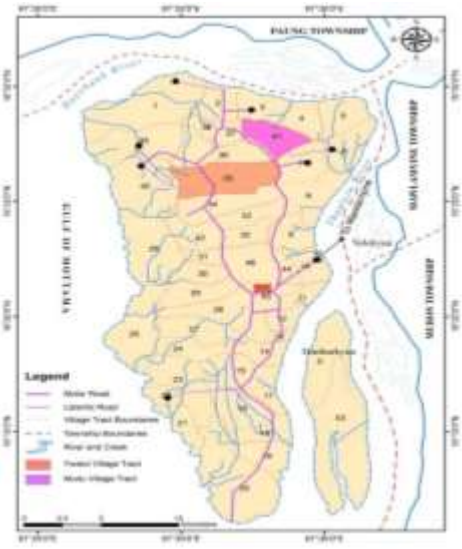
Chaungzon Township is one of the ten townships in Mon State. It is located in the western part of Mawlamyine Township. It lies between latitudes 16° 8' N and 16° 32' N and longitudes 97° 21' E and 97° 38' E. It has an area of 658.13 km^2 or about 5.35 per cent of the total area of Mon State. Chaungzon Township is located 10-minute driving time from Mawlamyine, the capital of Mon State. Slates are a unique product of Mudu Village because plenty of the slate is extracted near Mudu Village.

Source: MIMU

Figure 1 Location of Chaungzon Township

Source: MIMU

Figure 2 Wards and Village Tracts of Chaungzon Township



Source: MIMU

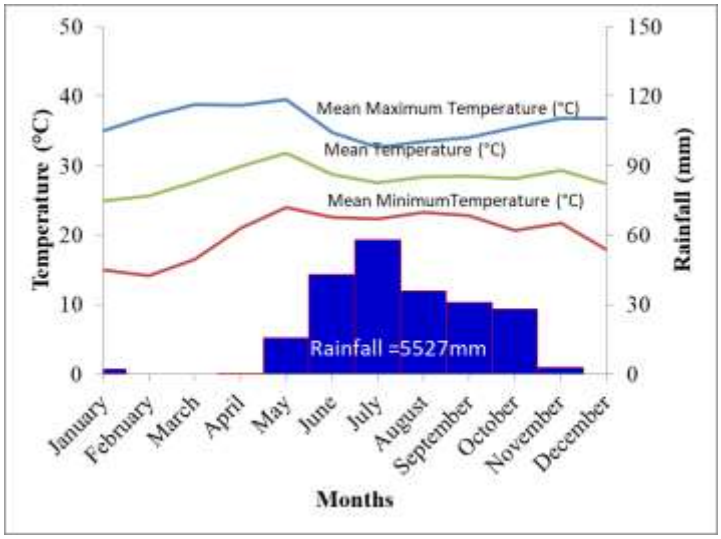
Figure 3 Study Areas (Ywalut and Mudu Village Tract) in Chaungzon Township

Social Background of Chaungzon Township

The topography can be divided into two parts: ranges and lowlands. Ranges lies in the central part of the township, generally trending from north to south. The ranges rise from 100' to 600' high above sea level. The foothill is below 50' above sea level.

Temperature is high throughout the year, because the township is in the tropical region. Range of temperature is small due to nearness to the Gulf Mottama. During 14 year- period from 2002 to 2015, the mean minimum temperature in January is 24.62° C (76.31° F).

The average monthly mean maximum temperature in April is 30.55° C (86.99° F). There is an average range of mean temperature of 5.93° C (42.67° F). Total rainfall is 5527 mm and the study area is one of the areas that get higher rainfall due to its location. Therefore, slate extraction has not been done in the rainy season owing to high risks. The area experiences tropical monsoon (Am) climate.



Source: Meteorology and Hydrology Department, Yangon

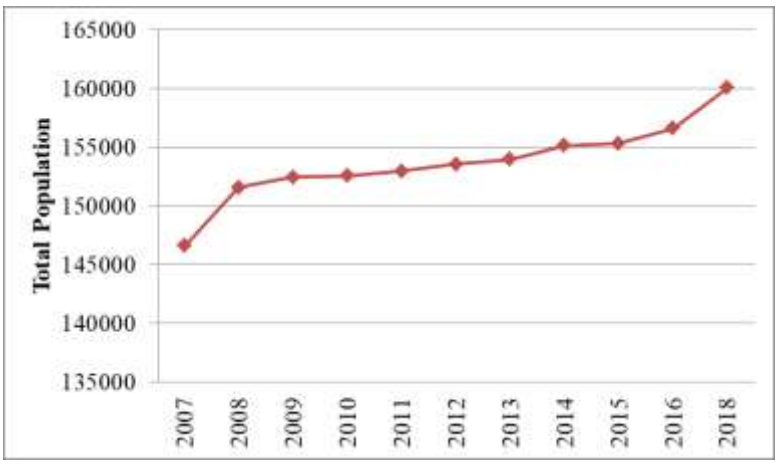
Figure 4 Temperature and Rainfall of Chaungzon Township (2008-2019)

Demographic Background of Chaungzon Township

In 2008, population of Chaungzon Township was 151573 and it increased to 153956 in 2013. Then, population increased to 160065 in 2018. The population increased due to natural increase and migration.

Physical Features of the township influence the population distribution. Generally, the foothill areas of the central ridge are the most populated because of fertile agriculture land, easy accessible road transportation and higher ground above the level of flood. The western part is sparsely populated due to the low level plain and flooding. The eastern and northern part of the township is densely populated.

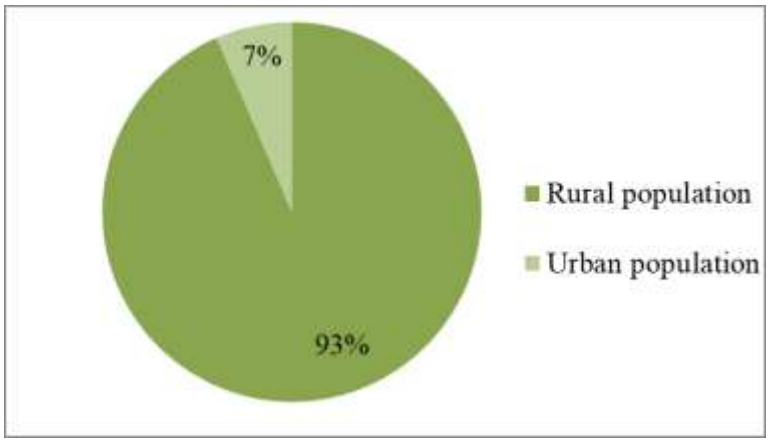
Population density of Changzon Township was 233.31 persons per sq-km in 2012 and it increased to 237.98 persons per sq-km in 2016. Population density of Changzon Township was 243.2 persons per sq-km in 2016. Ywalut and Mudu village tracts are of medium population density with between 501 and 1000 person per sq-km.



Source: Labour, Immigration and Population Department , Chaungzon Township

Figure 5 Population Growth of Chaungzon Township (2007 to 2018)

Urban population is 7 percent and they depend on secondary, tertiary sector and etc. The rural population is 93 percent that depends on primary activities such as agriculture, fishing, etc.



Source: Labour, Immigration and Population Department, Chaungzon Township

Figure 6 Urban and rural population for Chaungzon Township

Chaungzon Township is famous for traditional products such as pipe industries, walking stick industries, bamboo products industries, other handicraft industries, slate and slate pencils industries and rubber rings industries and people in this region work in traditional manufacturing activities.

Skilled labour is one of the important factors for the development of manufacturing activities because manufacturing activities chiefly depend on the sophisticated machine and the use of manual labour in the study area. According to data of General Administrative Department, Chaungzon Township, nearly 10 percent of the total population engages in manufacturing activities including pipes, slate and slate pencil production.

Results and Findings

Manufacturing Industries of Chaungzon Township

There are many types of manufacturing industries in Chaungzon Township. They are pipe industries, walking stick industries, rubber rings industries, bamboo products industries, rice mill industries, saw mill industries, purified drinking water factories, blacksmith industries, goldsmith industries, slate and slate pencils industries, concrete industries and furniture industries, etc.

Among them, pipe industries and slate and slate pencils industries were selected to be presented because of unique local traditional economies that are mainly found in Chaungzon Township within Myanmar.

Table 1 Manufacturing Industries of Chaungzon Township

Type	Type of Industries	Total	Percentage
1	Pipe industries	7	1.1
2	Walking stick industries	3	0.5
3	Rubber rings industries	3	0.5
4	Bamboo products industries	301	45.4
5	Rice mill industries	111	16.7
6	Saw mill industries	31	4.7
7	Furniture industries	21	3.1
8	Blacksmith industries	16	2.4
9	Steel and ironsmith industries	33	4.9
10	Goldsmith industries	15	2.3
11	Slate and slate pencils industries	15	2.2
12	Brick Baking industries	19	2.9
13	Concrete industries	21	3.1
14	Purified drinking water factories	3	0.5
15	Other handicraft industries	64	9.7
		663	100

Source: General Administrative Department

Traditional manufacturing industries in Chaungzon Township

Although there are many types of manufacturing, Chaungzon Township is famous for local traditional products production such as slate and slate pencils, pipe, etc.

Pipe industries and Slate and slate pencils industries

In Chaungzon Township, 7 Pipe industries and 15 slate and slate pencils industries are found. Pipe industry is only found in Ywalut Village Tract and slate and slate pencils industries in Mudu. Ywalut is a tourist attraction for its handcrafted pipes and while its neighbor, Mudoon, has been famous for producing writing slates.

Raw materials

Major raw materials needed for pipe industries are timber, stem made with fibre or rubber, super glue, polished oil, etc. Timber are obtained from Hpa-an, Mupon, and Belukyun at which parts of timer floating in rivers are collected to be used in pipe making. Some small timbers are also obtained from saw mills located in Belukyun. Super glue, polish oil, fiber are available from Malamyine and rubber stem from Bago.

Source: Researcher (12.5.2020)

Plate 1 Raw Materials for Traditional Pipe Industry

Source: Researcher (12.5.2020)

Plate 2 Raw Materials for Traditional Pipe Industry

Slate and slate pencil production need raw slate and timber only. Slate had extracted from Mudun Mountain of Belukyun but extraction from the area has been stopped due to low demand. Therefore, some owners have bought slate from Thahton for the purpose of continuing their work.

Source: Researcher (13.5.2020)

Plate 3 Raw Materials (Slate) for Slate and Slate Pencils Industry

Source: Researcher (13.5.2020)

Plate 4 Raw Materials (Timber) for Slate and Slate Pencils Industry

Teak and Padauk that are expensive are used only in pipe industries and raw materials for Pipe industry become scarce. Therefore, owners buy small parts Teak and Padauk tree from saw

mills as cost of Padauk tree is between 30000 and 40000 Kyats. The pipe made with teak is durable and that of Padauk is more beautiful.

Source: Researcher (12.5.2020)

Plate 5 Pipe production in traditional pipe industry

Source: Researcher (12.5.2020)

Plate 6 Pipe production in traditional pipe industry

Three size of slate are produced and the cost is 2500Ks per 100 sheets. Owners of the slate industries also buy trees to make frame of slate and it costs 60000 ks or 80000ks.

Source: Researcher (13.5.2020)

Plate 7 Raw Slate for making slate and slate pencils

Source: Researcher (13.5.2020)

Plate 8 Processing in slate making

Processing

In pipe production, teak and Paduak are mainly used to make pipe although Yinkhat is used in pipe making. Workers firstly cut the timber and after that mold it manually or by small machine in necessary pattern. Then, to be smooth, the raw pipes are rubbed by sandpaper. Stem is put into the pipes and they are polished.

Price of pipe differs from one type to another. Pipes made with teak and padauk are more expensive than those made by Yinkhat. Price of pipe made with teak and padauk is about 8000 ks and that of Yinkhat is 1000 ks.

In slate making, raw slate plate is cut into various size depending on demand. To be smooth, slates are rubbed by files and then, they are painted black. Moreover, it is necessary to slate frames with timber. Timber is cut by saw and grooves are created in the middle of the frame to fix the slate. Price of slate differs depending on size.

Investment for pipe work is about 10 lakh and 50 lakh are needed for slate work. As the investment is not too much for these works, if demand is high, local people can perform the work by using family labour force. Sorayaei et al, 2014, said that technology improvement have the greatest effect on quality, export and marketing, and low cost. But, on the other hand, it will decrease employment opportunity for local people.

Labour

In pipe production, polishing was mainly made by female workers lase decades. But, at present, these processes can be done not only male workers but also female workers with the help of small machines. In slate production, painting and smoothening are mainly made by male workers and slate cutting and timber cutting are done by female labour.

Source: Researcher (12.5.2020)

Plate 9 Processing in Pipe Industry

Source: Researcher (12.5.2020)

Plate 10 Female Labour in Pipe Industry

Traditional manufacturing industries support job opportunity for local people because not only adult but also old-aged person can earn in these industries because of light work. 4 out of six pipe production, rental labour are used and the remaining works apply family labour only. 6 out of 8 slate and slate pencil works has rental labour. In these works , female and male workers receive equal wage with 7000 ks per day. No labour problem is found in the area due to sufficient family members.

Working period

Pipes are made all the year round in the area. Slate and slate pencil work is done from October (Thidingyut) to April (Thingyan) because raw materials are not available for slate and slate pencil making as slate cannot be extracted in the rainy season.

Working calendar

	J	F	M	A	M	J	J	A	S	O	N	D
Pipe making												
Slate and slate making												
			Working period									
			Stopping period									

Source: Interviews

Source: Researcher (12.5.2020)

Plate 11 Various Types of Pipe

Source: Researcher (13.5.2020)

Plate 12 Slate Production as a Souvenir

According to interviews, sixty seven percent of the pipe works applied new design in pipe production and they imitate the designs from design books and they create pipes with their Thirty three percent make pipes in traditional design. In slate production, they produce slate and slate pencils for the purpose of writing as well as for keeping as souvenirs.

Source: Researcher (12.5.2020)

Plate 13 Unique-designed Pipe (1)

Source: Researcher (12.5.2020)

Plate 14 Unique-designed Pipe (2)

Some foreigners buy expensive pipes with unique designs that are traditional or as souvenirs although they are expensive and foreigner particularly French often come to see pipe making processes.

Market

Pikes are not only sold in local area but also sent to Yagon, Bago, Rakhine. Ayeyarwady, Mandalay, Maymyo by car. Bogyoke Market is one of the major markets of pike because tourist arrived to Yangon visit Bogyoke Market and buy souvenirs produced in Myanmar. Four out of six pike work said the finished products are mainly sent to Yangon and remaining work said that buyers come to buy pipe once per month.

Slate and slate pencils were sent Manadalay depot and Mawlamyine last 10 years ago but they are sent to Mawlamyine, Hpa-an, Yangon, Rakhine State and these are stored in local store houses. At present, the demand of these local traditional products decrease due to replacement of modern products, raw material scarcity, less modernized designs, etc.

Present Situation of Local Tradition Product Production

Most owners make pipes and sell them at national markets including Rakhine State and Dawei. Some produce simple pipes because it is easier and quicker to be made. The traditional pike making industry dropped their significance in 1990s because of a lack of raw materials and

some skilled labout migrated from the village to other areas that have high job opportunity (Nyein Nyein, 2015).

Last 4 decades, People lived in Mudu Village mainly work in slate and slate pencils production and they sent these products to other areas in Myanmar. Slates were once an important stationary item for elementary students. Since last 20 years ago, students eventually stopped using slates and slate pencils and the industries gradually declined in importance. According to interviews, many slate workers have left the village to earn more money in other place.

Slate miners normally get about 10,000 kyat per day. They go down dark, dirty, and dangerous mines that are 150 feet in depth to extract slates and then, bring big pieces of slate back to the place where they cut them to get various size for slate making (Tin Thet Paing, 2017).

Demand is one of the main pillars for the growth of economic activities. According to interview, demand of local tradition products decreased due to replacement of other modern products. Generally, price of these products increases, but the economic return is still small due to higher raw material cost, labour wage, transportation cost, etc.

Seventy eight percent of the owners have new generations who are students. According to interviews with owners, although new generations are interested in the works on local tradition products, it is difficult to do as major economic activities for the family due to low economic return. If the demand and economic return are higher, they would like to maintain their local traditional product production.

The factors affecting declining traditional manufacturing industries

According to interviews with owners and labours, poor capacity utilization of slate is a factor declining the traditional manufacturing industries. Although it is true that slate and slate pencils are cheap and affordable, it is difficult to look the lesson erased again.

Second factor is Raw material shortages for the industries. As the slate has been extracted, the production becomes low and raw material shortage is found. As a consequence, price of raw slate increases due to high labour cost and scarcer slate.

Third factor is lack of strong market demand. As other modern written items were cheap and affordable, students mainly used note books and pencils last 30 years. Therefore, the demand decreased and it is one of the major causes declining traditional manufacturing industries.

The fourth is lack of technology up-gradation. Traditional manufacturing industries use old methods and old style of production, it is difficult to compete products produced by using modern technology.

Low income also affects traditional manufacturing industries. These works give low and irregular income for the owners and workers. As demand is low, production of pipe is also low. Therefore, workers get small amount of wage and the income derived from these manufacturing industries is insufficient for family survival.

Lack of coordination is a factor affecting the decline in these industries. There is lack of co-ordination both within owner groups local area and among owners, readers, technician, and labours as well as authorities concerned.

The last is unwillingness of young generation to continue to this profession. Most of the adult are unwilling to work the traditional manufacturing activities. Adults would like to earn in modern factories with regular high salary. These factors have led traditional industries to be vulnerable as well as declining.

Conclusion

Traditional manufacturing industries have been major economy of the Chaungzon Township.

Traditional manufacturing industries of Chaungzon Township are declining due to above mentioned factors. This will lead to collapsing the industries that support local economy, local income, local GDP, and job opportunity. Therefore, it is important to educate young generation on the role and value of local traditional products of the area. It is needed to share the knowledge, skills, process, and modern design of local traditional products through vocational training schools. It is necessary to maintain local traditional products as intangible cultural value and it will protect traditional manufacturing industries in Chaungzon Township. Local authorities need to coordinate with owners, technicians, designers and traders to upgrade these industries.

It is also needed to do further researches on technology availability, investment, skills, etc for the purpose of recovering the traditional manufacturing industries of Chaungzon Township. By conserving industries and supporting the needs for the production of traditional products, traditional manufacturing industries produce standard articles, traditional products will be a symbol of Myanmar's culture, local economy will be surely improved and they will take over large share of market.

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I would like to thank Dr Than Than Myint, Pro-Rector, Hpa-an University for her kind permission in presenting the research paper. I also thank to Dr. Myat Soe Khaing, Professor and Head of Geography Department and Dr. Myint Thida, Professor, Geography Department, Hpa-an, who have encouraged me to carry out this research work.

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THE PRELIMINARY STUDY ON IMPORTANCE OF SMALL AND MEDIUM ENTERPRISES IN MAWLAMYINE CITY

Ohnmar Thein[1], Myint Thida[2], Thant Zaw Oo[3], Win Thanda Oo[4]

Abstract

The paper tries to present "the preliminary study on importance of small and medium enterprises in Mawlamyine City". The study area is located at accessible area and it has locational advantage to develop industrial sector especially SMEs. Mawlamyine City possesses 737 Small and Medium enterprises of which 562 Small enterprises and 175 Medium enterprises are included. They are important for local economy because existing agriculture give low and irregular income for local people. Growth of SMEs reduces unemployment rate, increases GDP and support local people through job opportunities for skilled and unskilled labour. But, SMEs of Mawlamyine City encounters the constraints that hinder SMEs development. The objectives of the paper are to examine present economic activities of Mawlamyine City, to explore the supports of SMEs on economy of Mawlamyine City, to find out the constraints affecting on SMEs of Mawlamyine City and to predict future prospect on SMEs of Mawlamyine City. Geographic methods and GIS tools were applied and, exploratory approach was used in doing the research work.

Keywords: SMEs, unemployment rate, skilled and unskilled labour, constraints, importance

Introduction

Small and Medium Enterprises (SMEs) play an important role in the economic development of developing countries. SMEs are assumed as an influential factor to boost up the economic development (ACMA, 2015). Raw materials, power, land, marketing, transport, technical facility and finance are major pillar for SMEs development. Khandker (2014) also said that electricity supply is the prerequisite for SMEs' development as well as its success.

After destruction of Black Market supporting higher income and miscellaneous job opportunities to local people, major economic activities are agriculture related economics including rubber plantation in Mawlamyine City. Existing economic activities such as agriculture including rubber plantation, etc do not support sufficient income for local people due to low and irregular income. Therefore, secondary economic activity especially small and medium enterprises became major pillar for the economy because it gives regular income, Job opportunities, and reduces number of unemployment as well as increased GDP of Mawlamyine City.

Like other areas, SMEs of Mawlamyine City encounter the constraints. Tambunan, 2011, stated that constraints differ from place to place. Common problems of SMEs are concerned with raw materials, power, land, marketing, transport, technology and commerce, lack of suitable technology, foreign markets, management skills and proper training, and finance ineffective laws as well as low official capacity. Domestic market competition is also constraint to SMEs' development. In the study area, constraints affecting SMEs' development are small market size, low demand; technical factors, skilled workers and electricity availability. To present the importance of small and medium enterprises, Mawlamyine City was selected.

Study area

Mawlamyine City located in Mon State lies between 16° 24′ to 16° 31′ North Latitudes and between 97° 36′ to 97° 40′ East Longitudes. It is located accessible place having locational

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advantage for economic development. It has been known as popular Black Market supporting local people as well as people lived in nearby town. After the market, economy collapsed agriculture and small scale business play important role in economy of the area.

O**bjectives**

Objectives of the paper are:

- To examine the present economic activities of Mawlamyine City
- To explore the supports of SMEs on economy of Mawlamyine City
- To find out the constraints affecting the development of SMEs in Mawlamyine City
- To predict future prospect on SMEs of Mawlamyine City

Data and Methodology

Primary data were collected by field observation, interviews and questionnaires. 12 interviews (one from each small and medium enterprise) were done to understand views of local people, authorities, staff and SMEs' owners on SMEs were collected. 120 questionnaires (10 questionnaires for each small and medium enterprise) were distributed to get their perceptions and to understand the constraints affecting on SMEs in Mawlamyine City. Data collection was done between Nov, 2019 and June, 2020.

Secondary data were obtained from department concerned to present the present situation of SMEs in the area. In illustration, Geographic methods and GIS tools were applied. In presenting the paper, exploratory approach was used.

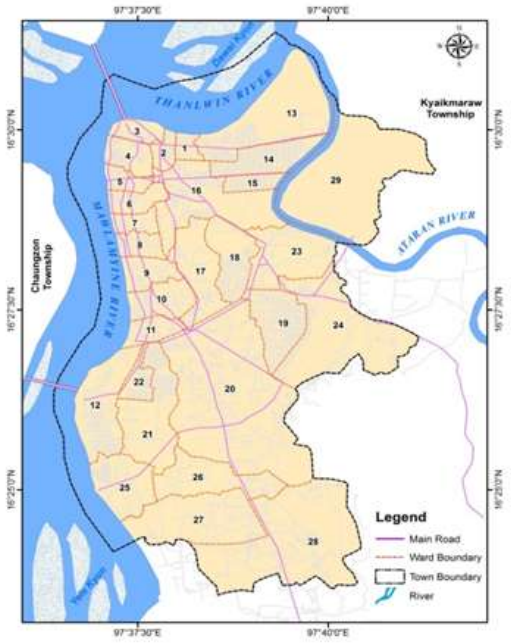
Geographical Background of Mawlamyine City

Mawlamyine City, Mon State's capital, it consists of 29 wards and has an area of 26387 acres (or) 41.23 sq miles (or) 106.79 sq km. It takes only 5 hours driven time from Yangon, Capital of Myanmar.

The western part of the plain is coastal plain of Yankin Range and Thanlwin River. The height is between 25' and 50' above sea level. The low land area supports establishment of settlement and economic activities for the people.

Figure 1 Location of Townships in Mon State

Source: Land Survey and Land Records Department, Mawlamyine Township



Wards Index	
1	Kyaikpane
2	Aukkyin
3	Mandalay
4	Hpettan
5	Shwedaung
6	Sitkegone
7	Mayangone
8	Pabedan
9	Bogone
10	Maungngan
11	Kwinyat
12	Mutpon
13	Shwemyinethiri
14	Zayyarthiri
15	Tharyaraye
16	Hlaing
17	Myenigone
18	Zayyarmyine
19	Myinetharyar
20	Zegyo
21	Thirimyine
22	Thirimingalar
23	Ngantae
24	Chaukmile
25	Kyauktan
26	Sangyi
27	Gwegone
28	Naungkari
29	Nyaungbinseike

Source: Land Survey and Land Record Department Mawlamyine Township

Figure 2 Wards in Mawlamyine City

Thanlwin River is the main river and flows along the western and northern boundaries of the city. The Gyaing and Attaran Rivers join into the Thanlwin River in the north of the city.

The maximum temperature is 36.94°C in March and the minimum temperature is 16.43°C in January during the 30 years period. The average total annual rainfall was 4966.48 mm in Mawlamyine City. Mawlamyine City lies within the seasonal shifting monsoon wind belt, and hence experiences a tropical monsoon (Am) climate and weather and climate of the area do not hinder economic activities.

The population of Mawlamyine City was 249680 persons in 2015 and 219553 persons in 2016, 247140 persons in 2017, 248492 persons in 2018 and 232,073 persons in 2019.

Results and Finding

Economy of Mawlamyine City

Last 30 years ago, Mawlamyine City was famous as black market selling garments accessories, etc. After practicing market oriented economic system in Myanmar, number of commercial activities decreased because most goods are directly carried to Yangon because of better accessibility. Since that time, role of Mawlamyine City in trading decreased and job opportunities has been decreased.

Like other areas, one of the major economic activities is agriculture and agriculture land decreased because of urban area extension caused by population growth. Government constructed 5 new wards: Myinetharyar, Thirimingalar, Zayyarthiri, Tharyaraye and Zayyarmyine in 1989, and next new seven wards: Kyauktan, Naungkari, Chaukmile, Ngantae, Nyaungbinseik, Gwegone and Sangyi wards in 2015. As a consequence, areas of agriculture land were transformed as residential areas. Therefore, people engaging on agriculture moved to other area as migrant labours and some earn in other economic activities.

Areas around City and Zegyo, Sangyi, Gwegone wards were occupied by perennial crops such as Durian, Mangosteen, Rambutan, etc that give income for local people. But, it was cleared for residential area extension. Zayyarmyaing, Zayyarthiri and Thayaraye wards were appeared on le land at which paddy was extensively cultivated. Therefore, most people living in Mawlamyine City do not get income from agriculture activity.

Present Economic Activities in Mawlamyine City

At present, agriculture especially small scale vegetable cultivation are found as urban agriculture in Myenigone, Hlaing and Ngantae wards vegetable cultivation and Zegyo, Gwegone, Chaukmile rubber cultivation at fringe area of Mawlamyine City, but it does not give sufficient and regular income for local people.

Source: Field survey and Data from Agriculture Land Management Statistics Department

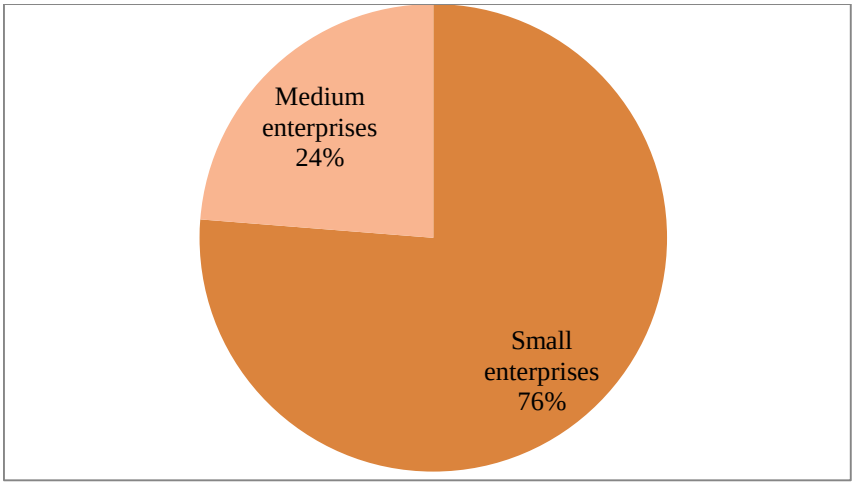
Figure 3 Vegetable cultivated areas of Mawlamyine City

Vegetable cultivators rent the land for vegetable cultivation. But, land rental cost is high and vegetable cultivation is sometimes at high risks due to price fluctuation, risks of pests, high input cost, etc. Therefore, some growers abandon the vegetable cultivation and they search the works that give higher and regular income.

Being located in the southern part of Myanmar, rubber is widely grown in Mawlamyine Township. Rubber plantations needs considerable amount of capital, but returns are delayed, it gives long term profit for many years. Low-yield variety is less cost-effective and some cultivators suspended tapping. There are two main costs associated with smallholder rubber production, material costs and labour costs. These costs are incurred throughout the life of rubber plantation. Rubber is exported to China and Thailand with low price because of low quality. The fluctuation of domestic rubber price is a reason declining rubber plantation as an economic activity in the area.

Small and Medium Enterprises in Mawlamyine City

In Mawlamyine City, total number of Small and Medium Enterprises is 737 of which 562 Small enterprises and 175 Medium enterprises are included.



Source: Planning Department

Figure 4 Number of Small and Medium enterprises in Mawlamyine City

Small and Medium Enterprises in Mawlamyine City are grouped into 7: Food and Beverage enterprises, printing and Publishing enterprises, Construction enterprises, Clothing enterprises, Household goods enterprises, Services enterprises and others.

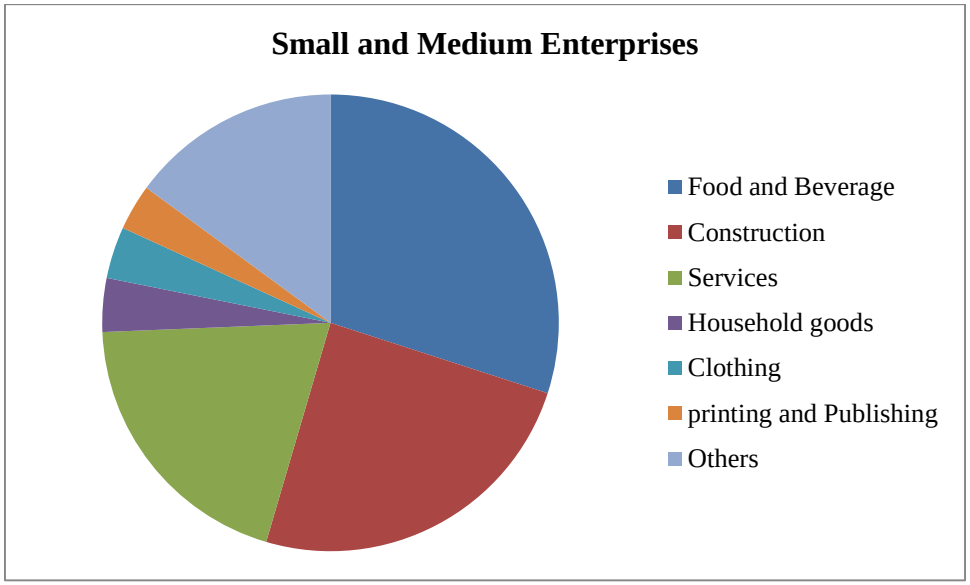
Food and Beverage enterprises	Tea Shop, Purified Water Shop, Snack Shop, Store, Grocery Shop, Rice Shop, Oil Shop, Dried Fishes Shop
printing and Publishing enterprises	Offset, publishing house, computer shop
Construction enterprises	brick shop, furniture, aluminum, iron sheet, window frame, iron door
Clothing enterprises	textile shop, bag, tailor,
Household goods enterprises	cosmetic, medicine, candle, box
Services enterprises	work shop, air con service, grinding work, phone service, car spare part shop, beauty parlor, etc
others	private schools, flower shop, rubber, game shop, etc

Among them, Food and Beverage enterprises rank first with 221 (30 % of the total Small and medium enterprises) due to first priority of the human's survival. Construction enterprises rank second with 181 (25 %) and it shows that development of the town. Printing and Publishing enterprises stand last with 24 (3.2% of the total Small and medium enterprises).

Table 1 Small and Medium Enterprises in Mawlamyine City

	Small enterprises	Medium enterprises	Small and medium enterprises	Percent
Food and Beverage	183	38	221	29.986
printing and Publishing	21	3	24	3.2564
Construction	145	36	181	24.559
Clothing	20	7	27	3.6635
Household goods	22	6	28	3.7992
Services	108	38	146	19.81
Others	63	47	110	14.925
Total	562	175	737	100

Source: General Administrative Department, Mawlamyine Township



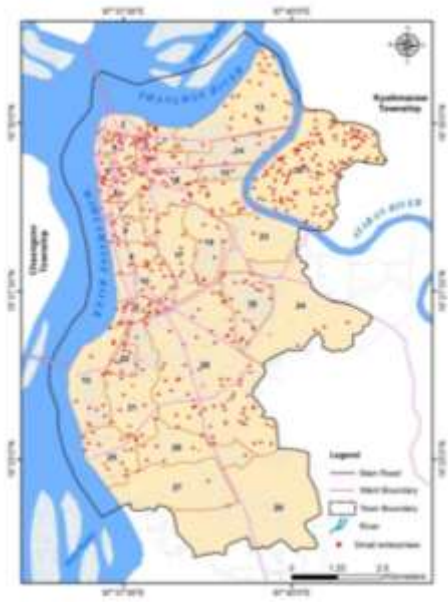
Source: Table 1.

Figure 5 Small and Medium Enterprises in Mawlamyine City

Distribution of Small and Medium Enterprises in Mawlamyine City

Number of Food and Beverage enterprises is largest in Hlaing and Zegyo wards possessing Wholesale areas. Smallest number is in Mandalay and Gwegone wards. Printing and Publishing enterprises are mainly found in Bogone, Aukyin, Phattan and Shwedaung wards.

Most construction enterprises are located in Nyaungbinseik, Sangyi and Naungkari wards and small number is in fringe area. Industrial zone of Mawlamyine Township is located in Nyaungbinseik Ward. Nyaungbinseik, Naungkari and Sangyi Wards have many saw mails, steel and aluminum construction works. Clothing enterprises are mainly concentrated in Zegyo, Ngantae, and Nyaungbinseik wards and small number of clothing enterprises in fringe area because area is mainly occupied by services. Most Household goods enterprises are mainly found in downtown area of Phattan, Mayangon and Shwedaund wards and small number is in Gwegone, Mandalay, Zayyarthiri and Tharyaraye wards. Zayyarthiri and Tharyaraye wards are newly extended residential areas flooded in the rainy season and many casual labours live there. Most servicing enterprises are concentrated in Mayangon, Kwinyat and Zegyo.



Source: Planning Department, Mawlamyine

Figure 6 Distribution of small enterprises in Mawlamyine City

Small enterprises are concentrated in Hlaing Ward (52), Zegyo Ward (63) and Nyaungbinseike Ward (145). The least number of small enterprises are found in Naungkari, Mandalay, Gwegone, Ngantae and Tharyaraye wards.

Largest number of medium enterprises is found in Zegyo Ward (10 medium enterprises), Naungkari Ward (31) and Nyaungbinseike (73). Small numbers of medium enterprises are located in Kyaikpane, Maungngan, Zayyarthiri, Hlaing and Myinetharyar wards. Mandalay, Sitkegone, Mutpon, Gwegone, Chaukmile, Thirimingalar, Zayyarmyine and Tharyaraye wards do not have medium enterprises.

Source: Planning Department, Mawlamyine

Figure 7 Distribution of Medium Enterprises in Mawlamyine City

Importance of Small and Medium Enterprises in Mawlamyine City

Small medium enterprises support local people in various ways such as reducing unemployment; giving regular income, increasing GDP, decreasing in number of migrant labour through supporting job opportunities for skill and unskilled labour, etc.

EBRD, 1995 pointed that SMEs' role in producing employment and social stability is crucial. Job opportunities provided by SMEs play a key role to reduce number of underemployment. Hill (2001) said that economic development is achieved by developing SMEs that job opportunity and Chowdhury, 2015; expressed SMEs generate job opportunities for the semi-skilled and unskilled labour. Thus it could decrease unemployment rate. Number of employed person is 156315 and underemployment 3985. Therefore, unemployment rate 4% of the total population. After reducing the role of agriculture in the area, job opportunities decreased and underemployment rate increased.

Unlike agriculture, SMEs support regular income for skilled and unskilled worker. According to semi- structured interviews and questionnaires' result, 74 percent of the labour are permanent and 26 percent are daily wage earners. Although their salary differs, they get regular income.

Growth of SMEs supports the growth of GDP in Mawlamyine City. GDP from increased in the area and GDP from industrial Sector including SMEs is 85367.1 mil and it is 83 percent of total trading value.

In Mawlamyine City, labour migration is distinct and they are at the age between 20 and 35 years old. They moved to other urban areas especially Yangon and Thailand to get higher income. They easily get high income because of high job opportunities that are regardless to education in urban area and Thailand. Many Industrial Zones were established in Yangon and job opportunities of one of the factors attracting migrants from other areas (Ohnmar Thein, 2019). Therefore, the growth of SMEs will reduce the labour migration affecting area's development.

Major Constraints for SMEs Growth

Quader and Abdulla, 2009, expressed these constraints affected on SMEs are very complex and interrelated. Constraints such as low investment affect the growth and function of SMEs (Hossain, 2018). Quader and Abdulla (2009) identified commercial constraints, governing constraints, and cost of high equipment, small domestic market size, lack of technically skilled workers, constraints on physical and technical factors and inputs are important for SMEs' development.

One of the SMEs problems is lack of available trained personnel (Çatal, 2007). Talebi et al. (2012) stated that industry - university or vocation training linkage is one the dominant factors for SMEs growth.

According to interviews, field observation and questionnaires' reply, commercial constraints, small market size, low demand, technical factors, skilled workers and electricity are found as constraints. Staff and authorities of SMEs in Mawlamyine City stress small market size, low demand; technical factors, skilled workers and electricity are major constraints on existing SMEs.

In Mawlamyine City, skilled labour availability is one of the constraints on SMEs growth. According to interviews, skilled labours are insufficient in SMEs of Mawlamyine City. After getting experience from local SMEs, they move to other areas to get higher income and greater experience and knowledge supported by enterprises. According to European Commission Report of 2009, to develop SMEs in an area, constant training and lifelong education are essential for

competitiveness and management. But, these training courses and qualifications are less available to staff earning in SMEs.

But, many unskilled labour are available for SMEs. But, like other areas, instability of unskilled labour availability is found due to movement from one enterprise to another.

Most products from SMEs of Mawlamyine City such as food and beverage enterprise, printing and publishing enterprise, construction enterprise, clothing enterprise, services enterprise, etc are mainly sold in Mawlamyine Township and nearby towns. Their market place is small and they do not compete the products imported from Thailand and China.

According to interviews with staff of clothing enterprises, best-selling clothes are Thailand made and young adult girls prefer readymade clothes made in Thailand to products of Mawlamyine due to low technology, design and durability. It somehow illustrates the low technology affects the development of SMEs through demand.

According to interviews with authority, electricity is one of the major constraints for SMEs' development. Like other areas in Myanmar, electricity cutoff is frequently found and it affects SMEs' production. According to interview, present electricity availability is better than the past.

Conclusion

In Mawlamyine City, food and beverage enterprises, service enterprises, construction enterprises, clothing enterprises, household goods enterprises and printing and publishing enterprises are mainly found. Among them, food and beverage enterprises are largest in number and construction enterprises second largest in number in the study area. Down town mainly possess service enterprises and construction enterprises are found in fringe area and in the industrial zone. Household goods enterprises are mainly concentrated in newly extended wards such as Myinetharyar, Thirimingalar, Zayyarthiri, Tharyaraye and Zayyarmyine, Kyauktan, Naungkari, Chaukmile, Ngantae, Nyaungbinseik, Gwegone and Sangyi wards for the purpose of supporting casual labour and daily wage earners.

Existing SMEs are important for local area because of reducing unemployment; giving regular income, increasing GDP, decrease in number of migrant labour through supporting job opportunities for skill and unskilled labour, etc. The major constraints affecting SMEs' growth are small market size, low demand, technical factors, skilled workers and electricity, etc. Lack of skilled workers and technology affects SMEs' development. Most of the workers in SMEs are not properly skilled.

Therefore, it is also needed to grow SMEs that can fulfill the demand of the present market. It is needed to systematic business plan and support of the government and departments concerned for the purpose of getting higher technology, financial support, etc. It is needed to do further researches on permanent and daily labours, skills on SMEs, quality of raw materials used in SMEs, etc to get SMEs development in the near future.

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CYCLONE RISK PREPAREDNESS AND RESPONSE IN RAKHINE STATE, MYANMAR: INSTITUTIONAL BASED ANALYSIS

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Abstract

Rakhine State is claimed to be the most disaster-prone area in the country. Rakhine state faced 13 times of cyclones between1948-2017. Among them the cyclone that hit the area in 1968 killing 1037 people and cyclone Marlar that lashed in 2006 leaving 37 deaths were the most destructive. Myanmar ranks first as "most at risk" country in Asia. Tsunami, Cyclone and storm surge affected all coastal areas (2004 Indonesia Ocean Tsunami, 2006 Marlar Cyclone, 2008 Nargis Cyclone, 2010 Giri Cyclone, 2015 Komen Cyclone). National Disaster Management Committee was reformed in 2016 in Rakhine state for preparedness and emergency response plan. Risk perception is strongly associated with disaster preparedness because individuals must perceive a risk to be motivated to initiate preparedness actions (Kanakis et al (2016). Myanmar Action Plan on Disaster Risk Reduction (MAPDRR) was introduced (lastly updated in 2017) and a year later the legislation passed the Natural Disaster Management Law. In the Action Plan of 2017, 32 priority actions have been formulated. For these priority actions, responsibilities are defined for different administrative and spatial levels. The paper based on the institutional preparedness and response for cyclone risk in Rakhine state. Semi-structured interviews, Likert scale and qualitative methods to analyse experts interviews such as institutions in Sittway town which are involved in disaster risk management and preparedness are also conducted with ward administrator and local experts and different institutions. twenty expert interviews conducted were in beginning of 2020. Statistical data collected from Department of Disaster Mangement, Natural Resource and Environmental Conservation etc;. This paper examines how risk preparedness varies among institutions and community levels.

Keywords: Rakhine state, awareness, preparedness, risk, cyclone, Likert

Introduction

Rakhine State is the least developed of Myanmar's 14 states and regions and is characterized by widespread poverty, weak infrastructure and a lack of opportunities for employment and income generation. This is exacerbated by the state's vulnerability to natural disasters, and prolonged internal displacement of around 140,000 IDPs as a result of communal violence. The World Bank has estimated poverty incidence in Rakhine to be the highest in Myanmar at 78% - set against a national average of 37.5% - and it is thought that some 416,000 people are in urgent need of humanitarian assistance. Rakhine state has seven main risks: flooding, cyclone, tsunami, landslide, forest fire, earthquake and river bank erosion. Among all this paper focuses on cyclone risk. Rakhine state is located approximately between latitudes 17°30' north and 21°30' north and longitudes 92°10' east and 94°50' east. It has an area of 36,762 square kilometres (14,194 sq mi) (Figure 1).

Coastal areas in Myanmar which have been affected by cyclones include mostly Rakhine state and Ayeyarwaddy Region. The Rakhine state was prioritized for the development of a specific Contingency Response Plan (CRP), due to the existing protracted emergency with 140,000 IDPs and other affected populations, the high levels of vulnerability, low levels of preparedness in communities, and the limited local capacities and resources (Myanmar Emergency Response Preparedness Plan (ERPP) 20. 2014. In Myanmar, multi-hazard risk assessments have been conducted in some hazards prone areas, such as the delta and Rakhine State (assessment carried on

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by UNDP). These initiatives should be extended to other hazards prone areas to cover the whole country. Taking into consideration climate change, multi-hazard risk assessments should also cover climate change risks. Rakhine state is particularly vulnerable to the impact of tropical cyclones – in particular the townships of Sittway and Maungdaw. Local communities and institutions interviewed on hazards and risks recently identified cyclones and associated storm surges as the primary hazards in the 13 coastal townships of Rakhine state. One of the other key elements of the development challenges facing Rakhine state is the limited scope of livelihood prospects and opportunities for income generation. This has created a cycle of food insecurity and indebtedness where food insecure households take out loans to meet immediate needs. The situation contributes significantly to the instability that constitutes a major push factor for irregular migration. Compounding the already challenging circumstances is the impact of natural disasters on livelihoods. Farmers are affected by cyclones through damage of crops/paddy fields, livestock, seeds and key assets, with the result that they often experience difficulty in restarting their farming and cultivation activities. Similarly, fishermen are at risk of losing their vital equipment and having their boats damaged in cyclones or storm surges.

Rakhine state effected 13 times of cyclones between 1948-2017. Extremely Severe Cyclonic Storm (Nargis) caused the worst natural disaster in the recorded history of Myanmar during early May 2008. Poverty and low infrastructures increase vulnerability and capability to recover from disasters. The millions of people injured, and many encountered hunger hungry and homelessness. More than 700,000 homes were fully or partially destroyed. Nearly 75 percent of health clinics were destroyed. The UN estimates that as many as 2.4 million people were affected. Nearly 140,000 people died and 2.4 million were severely affected. (Myanmar: Cyclone Nargis 2008 Facts and Figures. Published: 3 May 2011 12:16 CET)

International Organization for Migration (IOM) Myanmar has been implementing DRR Projects since 2012 and has carried out necessary measures for the rehabilitation of damages caused by Cyclone Nargis (2008) and Cyclone Giri (2010) based on regional experience and less on learned from IOM's response. IOM supports state and township governments by increasing their capacity and readiness to manage disasters and to reduce their impact. IOM and Disaster management committee Rakhine state had drawn Rakhine State Emergency Response Contingency Plan in 2019 (IOM, 2019).

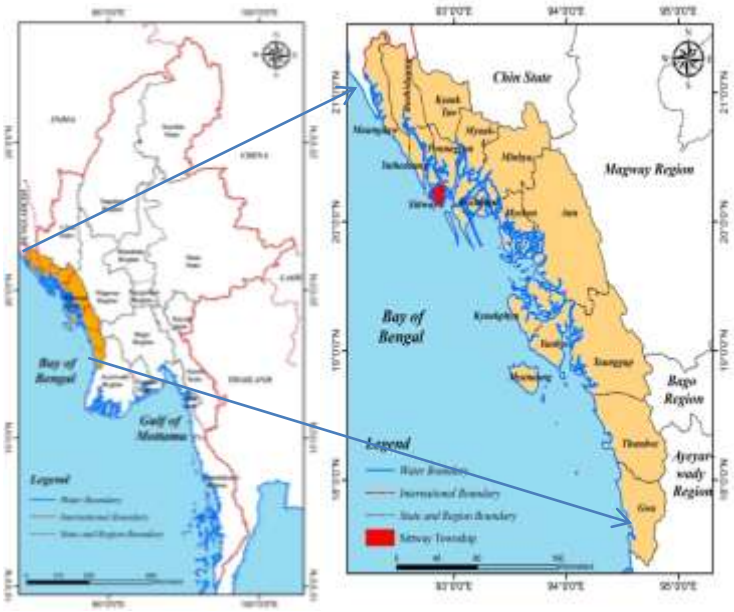
Developing countries, such as Myanmar, have often failed to implement risk management strategies: awareness and preparedness. Risks preparedness is one of the important things within the disaster management cycle. Preparedness is defined by United Nations International Strategy for Disaster Reduction (UNISDR) as knowledge, capabilities and actions of governments, organizations, community groups, and individuals ''to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions''. Preparedness efforts range from individual level activities (such as first aid training), to household actions (stockpiling of equipment and supplies), community efforts (training and field exercises), and governmental strategies (setting up early warning systems and contingency plans, the development of evacuation routes, and public information dissemination).

Risks have inflicted a heavy cost on human, material and physical resources. It is strongly associated with disaster preparedness because individuals must perceive a risk to be motivated to initiate preparedness actions. (Kanakis et al. 2016).

IOM has been active in Rakhine State since Cyclone Giri (2010) with emergency health and shelter support. IOM currently is active in Rakhine State in the fields of Camp Coordination and Camp Management (CCCM) capacity-building support, disaster risk reduction (DRR), IOM Myanmar mainly works in five townships – Maungdaw, Myinbya, Pauktauw, Sittwe, and Myebon

– which are the most risk prone of natural disasters and which have the highest number of IDP caseloads. (IOM appeal (Myanmar / Rakhine state) (April 2016 - April 2018)

IOM leads a consortium implementing the Program for Improved Disaster Management and Resilience against Natural Disaster in Rakhine State (IDM-RAND) targeting Sittway, Minbya, Myebon, Pauktaw and Maungdaw Townships in partnership with Agency for Technical Cooperation and Development (ACTED), Asian Disaster Preparedness Center (ADPC), Swiss Center for Development Cooperation in Technology and Management (SKAT) and Swanyee Development Foundation, funded by the United States Agency for International Development (USAID) / Office of US Foreign Disaster Assistance (OFDA).



Source: Myanmar Survey Department, 2020

Figure 1 Location of Rakhine State

Research aim and key research questions

The aim of this research is to understand the risks challenges for Rakhine state in detail, in order to establish a comprehensive, integrative risk preparedness and response. This paper examines the past disaster experiences and loss of economic basis. This study also examines the profile and predictors of institutions and community disaster risk perception, awareness using preparedness knowledge, prior disaster experiences. Following research questions were set up:

1. What are the preparedness and response of institutions to meet the local people's needs and their results?
2. How is the state of awareness in the disasters and their risks?

In order to achieve the main aim the following objectives have been set up:

1. to analyse the preparedness and response of the respective institutions
2. to investigate the perception of the institutions according to their awareness for cyclone risk

These objectives have to do on the different institutions and different levels in particular the institutional/organizational level (authorities who are involved such as township administration, authorities of University, Department of disaster management, Natural resource and environmental conservation office etc.).

Materials and Methods

The conducted semi-structured interviewed contains in particular parts which ask in detail for the awareness of the people towards disasters (in particular for the cyclone), their own preparedness and their expectations towards activities of authorities/organizations in case of an extreme event as well as their knowledge and experiences about disaster protection and rescue measures.

The qualitative method was used in this paper as a main approach. Altogether 30 expert interviews with members of different institutions involved in the disaster issue have carried out conducted in 2020. (length: 45 min to more than an hour). The interviews were recorded (Bryman, A. (2012). Statistical analysis was also used in Risk assessment. Data collected from General Administrative Department, Natural Resources and Environmental Conservation, Department of Disaster Management, Fire Service Dept, and etc;

Finding and Suggestions

Myanmar is prone to cyclones and April, May and October to December are considered to be cyclone months based on the last 100 years record. In the last four decades, six major cyclones hit Myanmar; 1968 (Sittwe cyclone), 1975 (Pathein cyclone), 1982 (Gwa cyclone), 1994 (Maundaw cyclone), 2006 (Mala cyclone) and 2008 (Nargis cyclone). The Sittwe cyclone led to a loss of 1037 lives (MAPDRR, 2019-2015). Rakhine state includes five districts and 17 townships: Mrauk-U, Sittwe, Maungdaw, Kyaukphyu and Thandwe see (Figure 1). Rakhine state has seven main types of risk. Among them flooding is most frequent than others and the cyclones are most severe problems and cause more damage in Rakhine state, particularly cyclone in 1968: 1307 people lives and Marlar cyclone in 2006: 37 people lives and 428.56 million lost. The History of Cyclones in Rakhine state (1948-2015) and risk assessment by ranking are shown in Table (1) and Table (2).

Table 1 History of Cyclones in Rakhine state (1948-2017)

No.	Year	Name of Cyclone	Effective area	Damage
1	6 – 8 October 1948		Sittway	Some people lives, 10 million kyats lost
2	22-24October 1952		Sittway	10 million k
3	15 - 18 May 1967		Kyaukphyu	20 million k
4	20-24October 1967		Sittway	2 people lives, 10 million k
5	7-10 May 1968		Sittway	1037 people lives, 17537people lost, 10 million k
6	12-17 May 1978		Kyaukphyu	200 million k
7	1–4May 1882		Gwa	27 lives, 82.4 million k
8	16-19May 1992		Thandwe	27 lives, over 150 million k
9	2 May 1994		Maungtaw	Over 59 million
10	25-29 April 2006	Marlar	Gwa	37 lives, 428.56 million
11	22 October 2010	Giri	Kyauukphyu	254720 people lost
12	2015	Komen	-	-
13	31st May 2017	Mora	11 Tsps	

Source: Department of Disaster Risk Reduction, Sittway, 2020

Seven main risks in Rakhine state which include flooding, cyclone, tsunami, landslide, forest fire, earthquake and river bank erosion are shown in Table 2. The risks are defined into three rankings by their capacity in 17 townships: high, middle and low. Among 17 townships, Gwa township is higher in risk level than other townships and four main types of risk that affected: the area are Cyclone, Tsunami, Forest fire and River bank erosion.

Table 2 Risk Assessment in 17 townships, Rakhine state

No.	Township	Flooding less than 4, 4- 6(over 6 ft)			Cyclone (50-100 mph)			Tsunami			Landslide			Forest Fire			Earthquake			River bank Erosion		
		H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L
1	Amm		✔				✔			✔	✔			✔				✔		✔		
2	Buthidaung			✔	✔					✔		✔		✔					✔	✔		
3	Gwa			✔	✔			✔				✔		✔			✔					✔
4	Kyaukphyu			✔	✔				✔				✔	✔					✔	✔		
5	Kyauktaw	✔				✔				✔			✔	✔				✔				✔
6	Maungdaw		✔		✔				✔		✔			✔				✔				✔
7	Mynbya	✔				✔				✔			✔	✔				✔		✔		
8	Mrauk U	✔				✔				✔		✔		✔				✔		✔		
9	Mannaung			✔	✔					✔			✔	✔					✔			✔
10	Myebon		✔		✔				✔			✔		✔				✔		✔		
11	Pauktaw		✔		✔				✔				✔	✔					✔	✔		
12	Ponnagyun		✔			✔				✔			✔	✔					✔	✔		
13	Yanbyne			✔		✔		✔				✔		✔					✔			✔
14	Rathedaung			✔	✔					✔		✔			✔				✔	✔		
15	Sittway			✔	✔			✔					✔			✔			✔	✔		
16	Thandwe	✔					✔		✔			✔				✔	✔					✔
17	Taunggoke	✔					✔		✔		✔				✔			✔		✔		

Source: International Organization for Migration (IOM), Sittway town, 2019

Risk assessment in Rakhine State is analyzed on hazards, damage of people, impact on services, and loss of materials, institutions and vulnerability. Among the seven risks in Rakhine state, flooding ranks first and cyclone includes in the second ranking. But the amount of damages percent was by cyclone was higher than other risks between 1948 and 2015 with 16.39 percent of total damages see table (3).

Table 3 Assessment on Risk ranking and amount of damages in Rakhine state

No.	Types of Risk	Risk by ranking	Damage Amount (%)
1	Flooding	H	17.50
2	Cyclone	M	43.30
3	Tsunami	L	18.10
4	Land slide	L	12.20
5	Forest fire	M	2.00
6	Earthquake	L	2.40
7	River bank erosion	M	4.45

Source: Interviewed, Department of Disaster Reduction, Sittway, 2020

The cyclone risk areas are defined by wind speed, topography, land use and intensity of wind (IOM). Wind speed of cyclone is based on 50-100 mph. Cyclone risk areas of 14 townships in Rakhine state are shown in table 4.

Table 4 Cyclone Risk Area in Townships (50-100 miles)

No	Township	High risk area (sq/mile)	Middle risk area (sq/mile)	Low risk area (sq/Mile)	Risk Ranking		
					H	M	L
1	Amm	93.11	54.81	11.42	✔		
2	Buthidaung	99.78	66.52	115.8	✔		
3	Gwa	43.62	43.62	62.49	✔		
4	Kyaukphyu	45.24	28.1	79.21	✔		
5	Kyauktaw	16.42	24.8	0.77		✔	
6	Maungdaw	45.73	68.69	212.59	✔		
7	Mynbya	36.55	36.55	0.05		✔	
8	Mrauk U	28.94	30.61	0		✔	
9	Mannaung	20.31	13.6	79.06	✔		
10	Myebon	70.69	45.16	74.93	✔		
11	Pauktaw	24.34	63.16 99	99.14	✔		
12	Ponnagyun	24.43	34.82	33.67		✔	
13	Yanbyne	9.64	219.18	28.57		✔	
14	Rathedaung	45.24	28.1	79.21	✔		
15	Sittway	6.28	3	55.18	✔		
16	Thandwe	67.79	67.79	13.9			✔
17	Taunggoke	101.06	120.91	49.02			✔
	Total	**799.79**	**1103.07**	**1045.25**			

Source: Department of Disaster Reduction, Sittway, 2020

4.1 Preparedness and response of institutions

The preparedness are usually undertaken to ensure setting up of necessary arrangements, policies, equipment and training in order to deliver efficient response and relief (Arjumand Habib,2012). Natural disaster preparedness should include planning based on the characteristics of natural disasters, preparedness to overcome them and where it is not possible to overcome them, making preparations for evacuation and shelter. The preparedness activities are usually undertaken to ensure setting up of necessary arrangements, policies, equipment and training in order to deliver efficient response and relief. In the post disaster situation, effective response guarantees that affected communities are provided with basic essential needs to begin the process of re-establishing normal community operations (MAPDRR). Nevertheless, the response activities have to be seen in a broader context as a part of the comprehensive set of arrangements which addresses all aspects of disaster management. Disaster preparedness and response of the governmental focal departments, such as Department of Disaster Reduction (DDR) and General Administration Department (GAD), is recognized as the key for strengthening DRR institutions in Rakhine state.

The natural disaster management committee organizes 24 institutions in Rakhine state. Preparedness and response of the committee set up 15 implementations. The followings are preparedness and response for cyclone risk in Rakhine state: Table 5.

Table 5 Preparedness and Response of institutions in Rakhine state

No.	Institution	Preparedness/ Response	Outcomes
1	Agriculture and Irrigation, Labour, Immigration and Population, Natural Resources and Environmental Conservation, ,Planning and Finance, Social Welfare, Relief and Resettlement, Home Affairs , Livestock, Fisheries and Rural Development, GAD	Data collection: population, animals, schools, building etc;	got real data
2	Transport office, Electricity department, Fire Service, Department of Meteorology and Hydrology, Police Force, Road and Building Department (SCDC), water Transportation, Department of Disaster Management, rail transportation, Myanmar National Airline, Communications and Information Technology	Define collection point: - use safety way	Reduction from risk
3	Township Trade organization, Social Welfare, Relief and Resettlement dept, Tsp General Hospital, GAD, Department of Education, Home Affairs, Township Transportation and Telecommunication office, Red Cross Society	Prepared emergency kits (food, water, medicine, recently photo etc; stored enough established warehouse supported from local and external	Response in time
4	SCDC, Fire service, Tsp Education office, Hydrology and meteorology dept, Health dept, Department of Disaster Management, GAD, Agriculture dept, Transportation and Telecommunication office, Tsp Red Cross Society, News and Information,	Information distribution regarding risk: -viber, Ph, manual,sms	Response in time
5	Department of Disaster Management, Transportation and Telecommunication office, Hydrology and meteorology dept	Decimated natural disaster law: - survey, discussed, suggested,	Duties and responsibilities

No.	Institution	Preparedness/ Response	Outcomes
6	News and Information, NGO, GAD, Fire Service Department	Awareness: - announcement, newspaper, pamphlet, survey	Preparedness, less damage
7	Department of Disaster Management , News and Information, local community	Drills: - Red cross, police - NGO, rescue team - drilled frequently, defined collection point,	Prevention, Evacuate in short time,
8	Township Trade organization, Social Welfare, Relief and Resettlement dept, Tsp General Hospital, GAD, Department of Education, Home Affairs, Transportation and Telecommunication office, Red Cross Society.	Prepared vehicles: - stay, collection, warehouse	Enough time to prepare
9	Department of Disaster Management	Prepared funding: - repair	Necessary things
10	SCDC, Fire service, Tsp Education Office, Hydrology and meteorology dept, Health dept, Department of Disaster Management, GAD, Agriculture dept, Transportation and Telecommunication office, Tsp Red Cross Society, News and Information.	Noticed: - communication - phone - mobile phone	Announcement to public
11	Tsp Rescue office	Prepared rescue: - district level - township - ward/village	Reduce damages
12	Department of Health	Prepared for emergency health care plan: - to care during risk time	- reduce side effect from risk -reduce damage
13	SCDC, Fire service dept, Tsp Education Office, Hydrology and meteorology dept, Health dept, Department of Disaster Management, GAD, Agriculture dept, Transportation and Telecommunication office, Tsp Red Cross Society, Township Trade organization, Social Welfare, Relief and Resettlement dept, Tsp General Hospital, Home Affairs,	Formed: emergency response team, mobile Red Cross team, training, workshop: State District township	Systematically implemented
14	Department of Disaster Management	Established: Emergency Operation Centre (EOC): capacity enhancement	Getting information in time, report back in time
15	Rakhine state government , NGO, INGO, CSO,	Rehabilitation: roads and bridges drinking water repair for damage fields livestock and fishing damage building	

Source: Interviewed and IOM, 2020

The Rakhine State Government, the Ministry of Education, and the Department of Disaster Management (DDM) coordinated in cyclone risk reduction. IOM has assisted with the reconstruction of six schools in Ponnagyun, Rathedaung and Buthidaung Townships which were affected by Cyclone Komen in 2015(IOM,2016-18).

4.2. The perception of the institutions

The paper analyses on the perception of the institutions to meet the disasters and their results. Analysis is based on interviewees of ten institutions.

Officer in Department of Disaser Management

"[…] *I give **awareness** training, workshops and drills to basic, middle, high schools and universities, industries, (SMEs) and local communities. I **arranged** workshop: one time per month for schools and universities and one time per three months for industries and public"* (ST 01).

Although students and public are aware of their training, they have no enough facilities: e.g training aids, cyclone shelters and so on. He said their area is a risk prone area that is why he wants to prepare emergency response facilities and materials.

Interviewed to University:

"[…] *As our state is a cyclone risk area I have an **idea** to define the **meeting** place at our university, convocation hall. There are safety ways and they can be reached frequently there by four entrance gates. Beside the hall is **enough space** for about 1000 people but not yet announced this information to my staff. The hall was defined as an temporarily building. I needs to confirm another more safety building.*" […] (ST 02).

He said University is *a meeting place of educated people/stakeholders that is why the respective intuitions should give training, workshops, and drills very frequently at the University.*

According to interview with the **officer of Transportation and Telecommunication office,** *he wants to prepare necessary facilities regarding communications for cyclone risk. Although their department has prepared communication facilities such as mobile, phone, sms,e- mail, satellite data connections and so on, sometime they encountered difficulty for smooth transportation. During cyclone risk, they need to contact with others related departments (police, hospital etc;) for emergency rescue for public from risk areas. But at that time transportation is a hindrance for them.* Some time they need to help their head of office, Yangon. *[…]"* (ST 03)

Most of the cyclone risk areas are coastal in Rakhine state. Whenever the cyclone risk occur, the mobile phone and others telecommunications are disconnected. Water and road transportations are also very difficult all the time in Rakhine.

Interviewed to expert in Natural Resources and Environmental Conservation:

As most of the people know that, Rakhine state is a seven risk areas particularly in13 coastal areas in Rakhine. *University Curriculum Disaster risk reduction is an emerging field and requires research and development on its various sub-themes. The sub-component 'Awareness through University Curriculum' aims to create awareness and also promote research. The course will be revised and accordingly course material will be developed. It will have component for research and development in area of disaster risk reduction*" [ST 04]

One expert: **Social Welfare, Relief and Resettlement:**

If cyclone arrives to risk area, we need to move the public to the safe places. So we need human resource and necessary things: enough vehicles. During and after cyclone has affected, the people need to evacuate to the places within three days or 72 hrs. When we move the people, we have to prepare enough space and safety buildings. When we move the people, we estimate distance, time, types of mode (bus or boat) and safety routes. Beside we should list not only numbers of people and goods but also numbers of animals before cyclone hits the areas

[ST 05].

One expert to Health Department:

If we want to move the public from risk areas, we need members of government, NGO, INGO, donators, volunteers, expertise from difference fields. We should prepare basic needs (emergency kits: foods, water etc;). Particularly, we should consider for other side effects on people after cyclone [ST 06]

The paper evaluates and analyzes on the cyclone risk in Rakhine state based on the difference perceptions of difference institutions. Particularly, the paper investigates the preparedness and response of institutions on cyclone risk in Rakhine state.

Conclusion and recommendations

The institutional preparedness and response in Rakhine state is linked with a lack of knowledge, local community attitudes, infrastructures: particularly transportation and systematic preparedness. Future education, communication and transportation campaigns should be more focused on the needs of intended public, taking into consideration of their usual sources of information and knowledge in relation to preparedness and response. A variety of strategies should be taken to increase community risk awareness, including emergency training, drills and workshop; mobilization of volunteers; emergency day event for publicizing purpose; and mass media (web, TV, radio, etc) campaigns. Women may become the major community because they are responsible for housing arrangements and are more likely to become well prepared than men. It is also important to emphasize the translation process from increased awareness into preparatory actions, possibly through emergency response exercises.

In 1948-2017, 13 times of cyclones battered in Rakhine state. Among them the cyclone in 1968: that took 1037 lives and cyclone Malar were more destroyed in 2006 with a death told of were the most:37 lives destructive (MAPDRR). Rakhine State is particularly vulnerable to the impact of tropical cyclones – in particular the townships of Sittwe and Maungdaw. Local communities and institutions interviewed on hazards and risks recently identified cyclones and associated storm surges as the primary hazards in the 13 coastal townships of Rakhine State.

The main recommend action of this paper relates to: behavior change and attitude modification within communities and stakeholders.

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A GEOGRAPHICAL ASSESSMENT ON SUSTAINABLE WATER SUPPLY MANAGEMENT OF EASTERN YANGON DISTRICT IN YANGON CITY

Lè Lè Mon[1], Khin Khin Soe[2], Myo Ma Ma Wai[3]

Abstract

Water is indispensable for the survival of all living beings. Access to clean, safe and reliable water remains a challenge to many people across the world, especially in developing countries. Myanmar faces a similar challenge, despite having ample water resources and reliable rainfall. In Yangon City, only38% of the population is received by City Water Supply, majority relying on alternative sources. This study explores the challenges of current City Water Supply System in Eastern Yangon District. Additionally, the aim of research is to evaluate the sustainable water supply management system and recommend actions that can be taken to improve supply of water to the city residents. A mix methods approach was employed in the study where quantitative and qualitative data collected. Quantitative data came from a household survey and interviews. Additionally, key informants were purposively selected and interviewed to provide in depth information on water related management and policy issues in the township level Yangon City as a whole. This study investigates the existing water supply system, water supply management, water qualities by sources and the amounts of water use. The water sources of the study area are rainwater, surface water and groundwater, of which groundwater is mostly used, being unable to get sufficiently from other sources in the dry season. The spatial variation of groundwater quality and whether the water is drinkable or not is checked by WHO Standard and Myanmar National Standard. The total numbers of tube well in the district have 89561. The test results of ground water sample, the contents of chloride, iron, turbidity, alkalinity, pH and total hardness are lower than the permissible levels of WHO and Myanmar National standards. The daily per capita water consumption is about 20gallons in average, lower than that of the YCDC standard (30 gallons).

Keywords: Ground Water, City Water Supply System, Water Quality, Drinkable, WHO, NHL, KII

Introduction

Water supply system is one of the basic infrastructures of urban development. Without water, human cannot survive and it is also a key to public health and environmental sanitation. Safe drinking water supply and adequate sanitation facilities are essential to public health and economic development of the nation. The availability of reliable water is becoming a problem throughout the world and is coupled with increasing population pressure. Over the next 30 year, it is expected that higher population growth rates will be in the urban areas of developing countries.

Sustainable water supply system should provide adequate water quantity and appropriate water quality for a given need, without compromising the future ability to provide this capacity and quality. Water system in the realm of sustainable development may not literally include the use of water, but include systems where the use of water has traditionally been required.

Myanmar is one of many developing countries that experience water scarcity across different urban and rural areas. Urban population in Myanmar is estimated to be approximately 30 % of total population (Census, 2014). Myanmar is endowed with rich water resources. Due to the varying topography and climate conditions, the rainfall is unevenly distributed leaving some regions of Myanmar, with an acute shortage of water. The study area is situated in the eastern part of Yangon City. This research work essentially focuses on existing water supply system,

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sustainable water supply management, the quality of supply water and the amount of water uses and future water supply and demand.

With the increasing population, the demand for water has been rising, so do the water sources. In the study area, inhabitants depend largely on surface water source and groundwater source. However, the limited availability of City Water Supply System (YCDC) water, people mostly depend on groundwater source. As the community tube well source became undependable, a greater number of households sank private tube wells and now there are 89561 tube wells within the study area of which 4449 tubewells sell water to the neighbouring households. Altogether 51 percent of the total populations of the townships depend on groundwater source.

Aim and Objectives

The main aim of this research is to evaluate the sustainable water supply management system of the study area from the geographical point of view. The specific objectives of this research work are:(1) to examine physical environment of the study area (2) to analyze the spatial variation of water supply system and water quality (3) to investigate the available water sources and to find out the ways of safe water supply system for growing populations.

Data and Methods

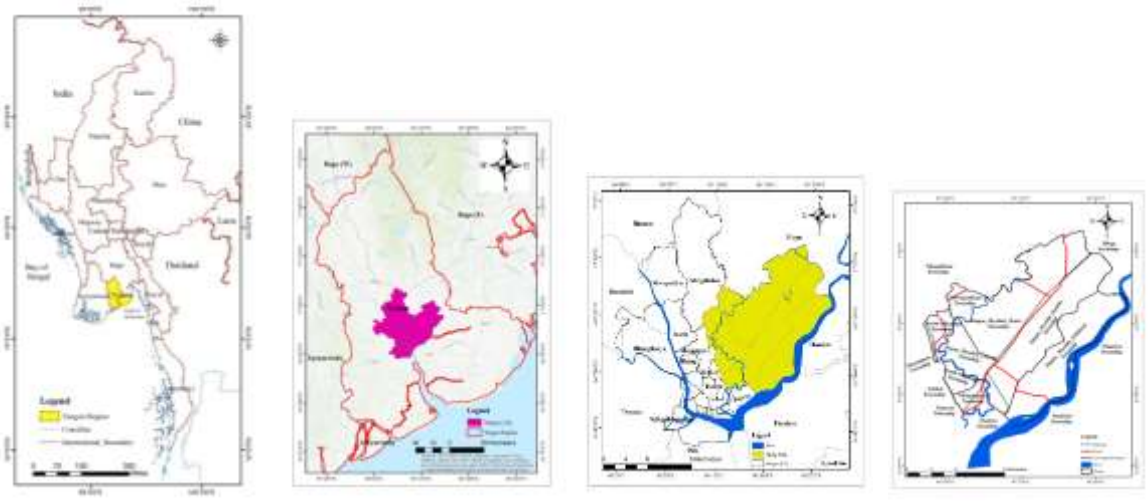
In order to have primary data, concerning water sources, water supply systems and water consumption, pilot surveys were first conducted and then questionnaire were prepared based on the information gained through pilot surveys. Table of Random Sampling Number is used in distributing the questionnaires. In addition, discussion and interviews with the inhabitants are also conducted to have in depth understanding of the problems or difficulties encountered by the residents of different townships.

Given the question that we sought to answer, a mixed method approach was found appropriate for the study, quantitative data was collected using a survey of household, randomly sampled in the District, while qualitative data was collected from relevant persons by using KII (Key informant interview's) analysis. Secondary data was also utilized in the study.

Based on the primary and secondary data available, graphs, diagrams and maps are produced using Microsoft Excel and GIS software. The sample waters are tested at National Health Laboratory, YCDC (Health Department) to identify the physical, chemical and bacteriological conditions of water. The test results are checked by WHO Guideline for Drinking Water Quality Standard (2014) and Myanmar National Standard. To assess sustainable water supply system in the study area, Multi-criteria analysis and SWOT analysis is used.

Study area

Eastern Yangon District lies between North latitudes 16° 46′ and 17° 2′ and between East longitude 96° 9′ and 96° 22′. It has an area of 127.5 square kilometre (99.95 square miles) constituting 8 townships. According to Yangon City Development Committee (water and sanitation department), eight townships and 239 wards are including in the East Yangon District. These are Thingangyun Township, South Okkalapa Township, North Okkalapa Township, Shwepaukkan, DagonMyothit (North) Township, Dagon Myothit (South) Township, Dangon Myothit (East) Township, and Dagon (Seikan) Township.



Source: Map Based on 1: 63360, Map No. (94-D1)

Figure 1 Location of East Yangon District

Results and Findings

Water supply systems of East Yangon District are somehow related to the location, relief, drainage, climate, geology, hydrogeology and soils of the township. The main sources of water within the study area are rainwater, surface water and groundwater. The annual rainfall is about 2807 mm (110.52 inches) and thus most households use rainwater in the rainy season. As the rainfall is highly seasonal, the long dry period which lasts for about 6 months is the main source of water shortage problem. In the dry season, most of the households are using surface water and groundwater, representing 37 percent and 69 percent respectively. This indicates the heavy dependence on groundwater, particularly tubewell water in the dry season, though the quality is below the permissible level. In response to the rising temperature and longer dry period, surface water, particularly pond water begins to dry up in the late dry season. At the same time the yield of water from tubewell also decreases, resulting in insufficiency of water for the inhabitants.

The population of the study area increased gradually from 633,450 in 1990 to 1,496,620 in 2020 with an average growth rate 1.7 percent per annum. The daily per capita water consumption is about 20 gallons in average, lower than that of the YCDC standard (30 gallons). For the townships Dagon Myothit (East), Dagon Myothit (South),Dagon Myothit (Seikkan), DagonMyothit (North) Township 63percent of the inhabitants use less than 20 gallons per day per head in average while 35 percent of that of people consume more than 20 gallons each per day. In Suburban area of the district, Thingungyun township, South Okkalapa township and North Okkalapa township use more than 25 gallons per day. The difference in the daily per capita water consumption depends on the water sources, water supply systems and socio-economic status of the inhabitants.

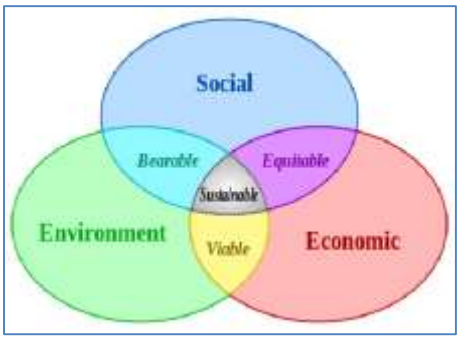
Water supply in East Yangon District is categorized into: City Water Supply System (YCDC) and non City Water Supply System. Approximately 90% of water supplied by YCDC comes from reservoirs, supplemented by tubewells. The water distribution is through pipes to the user. But non CWSS serviced areas, people have adapted to such various sources, tubewells, rain water storage, ponds, community tubewells and taps bottle water, water vendors, and also include small public water supply system. The water supply from available reservoirs can meet the needs of the existing population. However, there has been a lag between supply and demand because of many factors, including aging infrastructure, water leakages and inadequate pipelines connection in most townships. As highlighted earlier in the study, only 37% of the total households in East

Yangon District are reached by YCDC supplied water. The rest of population have relied on other sources. As relates to the infrastructure, over 60 years old age pipes are still operating especially in Thingungyun township, South Okkalapa township and North Okkalapa township. Approximately 48% of total daily supply is lost because the pipe line connections have not been rehabilitated properly. Furthermore, 87% of all connections are equipped with meter. The duration of water supply is highly variable. The availability of water depends on the distance from the water sources. The townships near the main distribution line or sources can get more in times of duration and amount. As such some households used motor to pump water from the main pipeline.

Based on calculated result, the average daily consumption of water within the study area over 33 million gallons. However, the CWSS source can deliver only about 15.19 million gallons per day and the remaining 17.81 million gallons have to be satisfied mainly by groundwater source, partly by surface water sources. Depending on localities, the depth of tube wells varies between 91.44 m (300′) and 182.88 m (600′). According to the test results of ground water sample, the contents of chloride, iron, turbidity, alkalinity, pH and total hardness are lower than the permissible levels of WHO and Myanmar National standards. The quality of YCDC water is within the maximum permissible level of WHO standards.

Discussion

Accessing the sustainable features in water supply, that three-fold goals of economic feasibility, social responsibility and environmental integrity, is linked to the purpose of water use. Sometimes, these purposes compete when resources are limited, for example, water needed to meet the demands of an increasingly urban population and those needs of rural agriculture.



Sources: researchgate.net/figure Triple-bottom-line-accounting

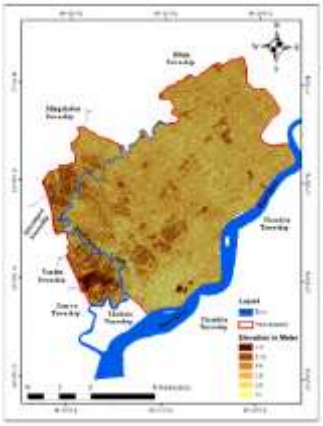
Figure 2 Three-fold goals of Sustainable water supply management system

Sustainable water supply is a component of integrated water resource management, the practice of bringing together multiple stakeholders with various viewpoints in order to determine how water should best be managed. In order to decide if a water system is sustainable, various economical, social and ecological considerations must be considered.

Physical environment such as location, relief and drainage, geology, climate, soils and natural vegetation affect the water sources and water supply of a given area. The study area, in fact, is part of the floodplain belts of the Ngamoeyeik Creek and Bago River and thus it has no salient topographic feature, characterized by flat, low plain with a general elevation of 5.49 metres (18 feet) above sea-level, although the land imperceptibly lowers towards the Bago river and Ngamoeyeik creek. These are the major drainage system of the study area. Ngamoeyeik Creek takes its sources over mountain spur of BagoYoma, at 19.3 km (12 miles) north of Phaunggyi in Hlegu Township and meandering with a series of sharp bands along the northern, western and

southern boundaries of the study area. On the other hand, it serves as one of the main sources of drinking water for the inhabitants of Yangon City. Generally the study area is part of Greater Yangon (Yangon City). Being lowlying plain, the topmost layer which is about 15.24 metres (50 feet) in thickness is fully covered with young alluvium of recent geologic time, underlain by valley-fill deposit with a thickness ranging between 36.58 metres (120 feet) and 91.44 metres (300 feet). In practice, rock units of Irrawaddy and Pegu Group are less significant for the extraction of groundwater due to their great depth. The availability of freshwater in the western part of District at depths over 152.44 metres (500 feet) is probably due to downthrown nature of the eastern side of Mingalardon-Yangon Fault, and shallow freshwater aquifers in Eastern Yangon District which may be related to the northern extension of Thingangyun-Thanlyin Anticline.

The annual mean temperature is 27.15 °C (80.87 F). The monthly mean temperature is highest in April with 30.4 °C (86.72 °F) and lowest in January with 24.9 °C (76.82 °F). Within the study area precipitation is high during the rainy season from May to October and low in the remaining period of the year. The average total precipitation in the period from May to October was 2696 mm of which 651.1 mm was evaporated, thus resulting in water surplus. However, the amount of precipitation received in January-April period was only 70 mm which the amount of evaporation was high with 615 mm. Thus the amount of water deficit in that period was 545 mm in the soils. The water surplus for the whole year is 1914.9 mm which occur in the period from May to October, while soil water deficit is dominant in the November to April period with 627 mm. If the surplus water can be stored by possible means, the water shortage problem in the dry season would be reduced. The meadow soil group is the most dominant characterized by high clay content. Along the both sides of the Ngamoeyeik Creek and Bago river are swampy soils (***Gleysol***) and meadow alluvial soils (***Gleysols and moderate Fluvisols***).



Source: Map based on 1:50000 UTM Map NO. (1696-01)

Figure 3 Relief and Drainage map

Source: Immigration and Man Power Department

Figure 4 Population density of East Yangon District

The social environment such as population growth, population distribution and density are also effect on sustainable water supply management in the study area. The District has 987,840 people in 2000 and population increased to 1,496,620 people or 25% of Yangon City in 2020. Annual growth rate is 1.7 percent. At this rate the population of the study area will double in the next 30 years, demanding two times of the present amount of water need. The population distribution of the district is highly uneven. More people are concentrating in suburban area such as Thingangyun township, south Okkalapa township and north Okkalapa township. Northern part of Dagon Myothit (East) township, Dagon Myothit (South), Dagon Myothit Seikkan township are sparsely populated due to low accessibility being close to the Bago river. The average population density was 11,738 persons per square kilometre (14,974 persons per square mile), much lower

than that of the inner townships of Yangon City which ranged between 100,000 and 200,000 persons per square mile. South Okkalapa township is the highest in population density with 20,211persons per square kilometre. These townships in fact, were former new town of Yangon City, settled since 1958 the establishment of the township. The township with lowest population density was Dagon (Seikkan) with 1457 persons per square kilometre.

The development of human society is somehow related to the availability of potable freshwater sources. Quality of available water, to some extent, affects the health of inhabitants of the area concerned.

Present water supply system

Rain water Harvesting

Rain water is the natural and fundamental sources of all water and it replenishes stream, pond and groundwater. Within the study area, rain water is received from the third week of May to the end of September, in some years to end of October. The source of rain is the moisture-being southwest monsoon wind and the average annual rainy days is 129 days. Generally rain water received during the period from June to October is sufficient for all types of use. In the study area 28.1% of household use rain water.

Surface water

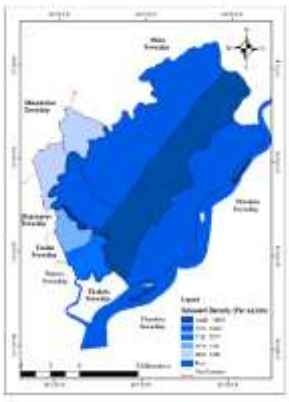
The existing surface water sources within the study area are ponds and Reservoir. There are 107dug-ponds for storing rain water in the district. The larger ponds were dug since human settled in this area as village units. Usually these ponds dry up in the later phase of dry season, resulting in water shortage problem for the households concerned which have to buy water. As highlighted earlier in the study, only 38% of the total households in Yangon City are reached by YCDC supplied water. The rest of population have relied on other sources. Approximately 90% of water supplied by YCDC comes from reservoirs, supplemented by tubewells.

Ground water source

Groundwater accounts for greater than 50% of global freshwater; thus, it is critical for potable water (Lozan et at, 2007). Groundwater can be a sustainable water supply source if the total amount of water entering, leaving, and being stored in the system is conserved. There are three main factors which determine the source and amount of water flowing through a groundwater system: precipitation, location of streams and other surface-water body, and evapotranspiration rate; it is thus not possible to generalize a sustainable withdrawal or pumping rate for groundwater (USGS, 1999). Unsustainable groundwater use results in water-level decline, reduced streamflow, and low water quality, jeopardizing the livelihood of ground-water pumpage, increasing recharge to the ground-water system, decreasing discharge from the groundwater system, and changing the volume of groundwater in storage at different time scales (USGS,1999). A long-term vision is necessary when extracting groundwater since the effects of its development can take years before becoming apparent. It is important to integrate groundwater supply within adequate land planning and sustainable urban drainage systems. There are 89,561 private tubewell in the study area. Most of the Tubewell are located in Dagon Myothit (South) Township. Altogether 74 percent of the total populations of the District depend on groundwater source. Depending on localities, the depth of tube wells varies between 300 and 600 feet.

Source: Water and Sanitation Department (YCDC)

Figure 5 Pipe Water Supply System



Source: Water and Sanitation Department (YCDC)

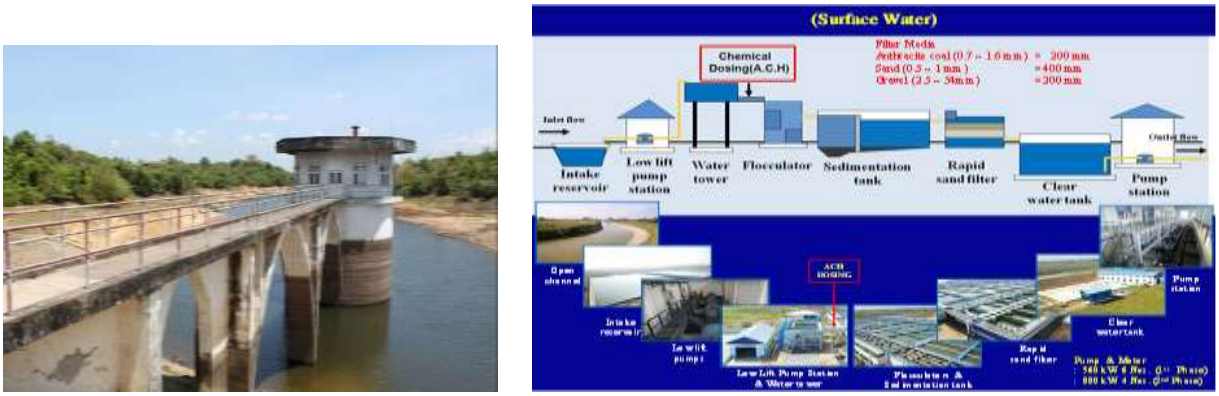
Figure 6 Tubewell density of East Yangon District

Assessment of sustainable water supply management in the study area

A water supply system with be sustainable only if it promotes officiencies in both supply and demand side. Collection water from precipitation is one of the most sustainable sources of water supply since it has inherent barriers to the risk of over-exploitation found in surface and groundwater sources, and directly provides drinking water quality. However rain water harvesting systems must be properly designed and maintained in order to collect water efficiently, prevent contamination and use sustainable treatment system in case the water is contaminated. A number of drinking water treatments exist at point-of-use, each with advantages and disadvantages. These include solar treatment, boiling, using filters, chlorination, combined methods such as filtration and chlorination, flocculation and chlorination. Although technically given the Earth's surface and precipitation, rainwater harvesting can meet global water demand, the solution can most practically be a supplement to sustainable water supply system given a level of uncertainty (especially with climate change), and competing land-use applications.

The water supply from available reservoirs can meet the needs of the existing population. However, there has been a lag between supply and demand because of many factors, including aging infrastructure, water leakages and inadequate pipelines connection in most townships. Among the 239 wards of 8 township only 112 wards receive piped water from Gyobyu reservoir, Hlawga reservoir, Ngamoeyeik reservoir. In the study area, sustainable water supply system from reservoir has operated by eight stage/ phase as open channel from creek, intake reservoir, low lift pumps station, water tower, flocculation and sedimentation tank, rapid sand filter, clear water tank, pump station to pipe connection figure(2). The daily amount of water delivered to the district is about 15.19 million gallons per day. Of the total 332,307households, only 121591 households (37 %) have now access to the piped water source.

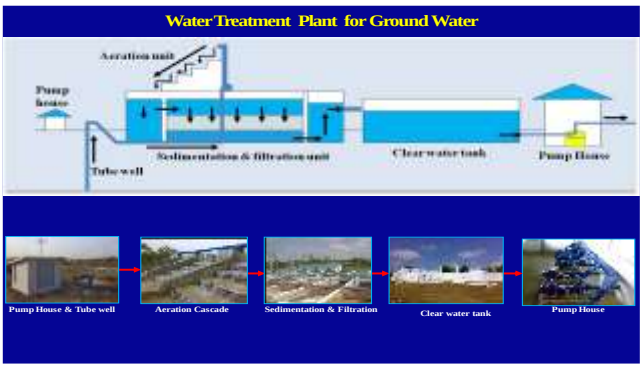
Ngamoe Yeik Creek → Ngamoe Yeik (water intake) reservoir → Pre-sedimentation tank → Addition of Aluminium Chlorohydrate [Al2Cl (OH) 5] in the water tank → Flocculation unit → Sedimentation tank → Rapid Sand Filtration → Clear well → Pump station → Distribution Network



Sources: Water and Sanitation Department (YCDC)

Figure 7 Sustainable water supply management system of Ngamoeyeik reservoir

To provide sufficient clean and safe water for household uses, industrial and construction uses, the Township Development Committee together with YCDC arranged access to central water supply system, delivering water to 128 wards of the township, covering 21 % of the District population. Local water supply system is based on the community tube wells and it can provide water to only 36 % of the total population. The wards that have the access to central water supply system depend largely on groundwater acquired through tube wells. The amount of clean and safe water that can be delivered depends on the means of sustainable water supply system and the materials used in the system. Water supplied by pipeline system from YCDC tubewell water that operate aeration cascade, sedimentation or filtration, use clear water tank, pump house and connect to pipeline shown in figure(3). It reaches directly to the residence attached with meter for measuring the volume of water uses by each household. There are 128 tubewell and 118 concrete tanks support by Yangon City Development Committee. The District now (2020) has 89561 private tube wells. Those cannot afford to sink a tube well have to buy water from the nearby houses that have tube well. Private water supply system support water to 46.91 percent of the population. The majority of the inhabitants buy purified water for drinking. Only a small proportion of the households can store rainwater and drink it all year round.



Sources: Water and Sanitation Department (YCDC)

Figure 8 Sustainable water supply management system of YCDC tubewell

Water Quality

Water quality is most important for the health of consumers. Within the study area rain water, surface water and groundwater are the existing water sources. As rain water is formed by condensation of moisture in the atmosphere, it is generally clear and less contaminated by impurities.This pure rainwater has a pH of about 5.6. To identify the quality of water in the study area water samples are taken from Dagon Myothit (North) township. According to laboratory test result the pH values are 7.4 compared with WHO standard (6.5-8.5) and National Standard (7 to 8.5).

Quality of Surface Water

Surface water of the study area includes pond water and water from Reservoir water, distributed by Central Water Supply System of Yangon City. There are 107 ponds within the study area of which ponds in Dago Myothit (North)Township and Dagon (East) township are taken. Both sample waters are slightly yellowish in physical appearance. Turbidity values are fairly high with 17 NTU in ward 51 and 30 NTU in Sitpintaung ward, higher than permissible level of WHO Standard (5NTU). The pH values are 6.9 and 6.6 respectively and thus they are within maximum permissible level both by WHO Standard and Myanmar National Standard.

Central water supply system of YCDC shares water to112 wards of the District, of which water samples from Ngamoeyeik reservoir water and Gyobyu reservoir water are taken for laboratory test. The physical appearance of sample water is clear and the turbidity value of Gyophu is 20 NTU, while that of Ngamoeyeik reservoir water has 7 NTU, including within the maximum permissible level by WHO standard. Water delivered through pipelines from Ngamoeyeik reservoir has no colour and odour, as it has been filtered by a series of filtering tanks and filtering machine before being sent into the pipelines. The sample waters include 9 mg/l of chloride respectively which are within maximum permissible level (250 mg/l) of Myanmar National standard. The pH values of the sample waters from 7.4 in Ngamoeyeik reservoir and Gyophu reservoir is 7.9 which is within the highest desirable level by WHO. The iron content is 0.85 mg/l in Ngamoeyeik reservoir water and 0.8 mg/l in Gyophu water lower than WHO Standard (1 mg/l). The pipe water contains no sodium nitrate, and the contents of nitrate, fluoride and chlorine are lower than WHO Standard and thus it is suitable for drinking.

Quality of Groundwater

The majority of inhabitants in the District rely on groundwater. Groundwater is bacteriologically free and safe, but more minerals usually dissolve in it. Water samples from 8 tubewells were collected for laboratory test. Quality analysis includes physical appearance, chemicals dissolved in the water, and bacteria included. Generally the wards located in the western part and eastern part are close to the Ngamoeyeik Creek and Bago river thus the groundwater is affected by the salty water. The aquifer lies at great depth and the water quality is relatively low with high content of undesirable chemical. The tubewell water is much affected by the stream water increasing the values of pH, Turbidity, Chloride, Alkalinity and Sodium Nitrite, much higher than WHO Standard. The water withdrawn from this area is favourable only for domestic uses. The eastern part of the township is fairly distant from the Ngamoeyeik Creek and the underlying acquifer is thick with yellow sand layer and therefore the water withdrawn from the tubewells of the eastern part is fairly good in quality.

Water Supply and Demand in the Study Area

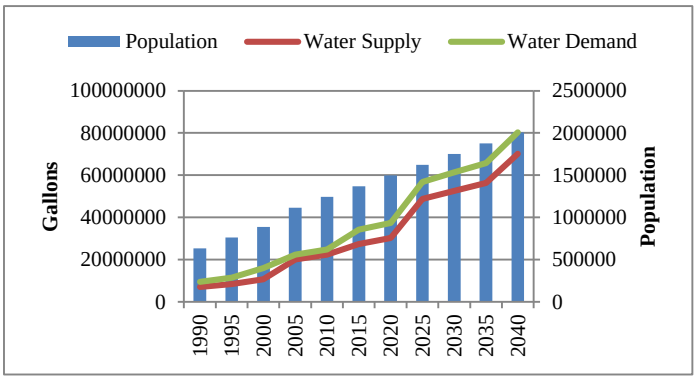
The basic requirements for water supply system are availability of ample water sources, maintainance of the system and means of delivery to the consumers. Initatives to meet demand for water supply will be sustainable if they prioritize measure to avoid water waste. Avoiding wastage will contribute to reducing water consumption and consequently, to delaying the need for new resources.

The Central Water Supply System of YCDC delivers 205 gallons of water daily of which 14 million gallons come from Hlawga Reservoir, 27 million gallons from Gyobyu Reservoir, 54 million gallons from Phugyi Reservoir,90 million gallons from Ngamoeyeik Reservoir and 20 million gallons from YCDC Tubewell. For the study area water is directly delivered through pipelines from Hlawga Reservoir, Gyobyu Reservoir, Ngamoeyeik Reservoir and YCDC Tubewell. The water is received by 121,591 households in 8 Township and the daily amount of water released for the District is 15.19 million gallons. The remaining households have to rely mainly on groundwater source which is generally low in quality. The future water demand and supply conditions are presented in Table(1) based on the current amounts of demand and supply, as well as in the previous time. The existing CWSS and LWSS cannot satisfy the need. On the other hand, the number of population has been growing rapidly. Unless necessary water supply projects are laid out and implemented, based on the number of population in next 10 years or 20 years, water shortage problem would be a great concern for the greater proportion of the inhabitants of the study area. It is learnt that a new water supply project is being implemented. The project is Lagumpyin Reservoir water treatment Plant from which 30 million gallons of water is to be delivered daily to the four townships of Dagon Myothit (North), Dagon Myothit (East), Dagon Myothit (South), Dagon Myothit (Seikkan) and Thilawa SEZ. Ngamoreyeik reservoir will promote for clean and safe drinking water and domestic water use by the ADB aid.

Table 1 Past and Future Water Supply and Demand of East Yangon District (1990-2040)

Year	Population	Water Supply	Water Demand
1990	633450	6967950	9501750
1995	760625	8367095	11409675
2000	887840	10654080	15981120
2005	1113035	20070630	22300700
2010	1242230	22360140	24844600
2015	1369425	27388500	34235625
2020	1496620	30231478	37415500
2025	1623815	48714450	56833525
2030	1751010	52530300	61285350
2035	1878212	56346360	65737420
2040	2005400	70189000	80216000

Source: Immigration and Man Power Department and field observation



Source: Based on table (1)

Figure 9 Past and Future Water Supply and Demand of East Yangon District (1990-2040)

The assessment of sustainable water supply management of East Yangon District is used SWOT analysis. The sustainability evaluation frameworks based on the multi criteria analysis as social, environmental, economic, risk-base and functional criteria.

Table 2 SWOT analysis on sustainable water supply management in East Yangon District

Criteria/ components	Strengths	Weaknesses	Opportunities	Threats
Social	-Fair user acceptance and willingness, - easy in user awareness and involvement	-Some people less public participation and contribution -less demand & supply management options -lack of support from institutions	- number of jobs it creates, - favourable for recreational values (ponds& reservoir) - more water uses knowledge and involvement	- Increase in population, - large amount of water uses, - human health and hygiene
Environmental	-abundant rainfall, -many ponds, reservoirs water, -easily to collect water -favourable condition for pipe connection (low relief)	-part of the floodplain, -less conservation on existing water resources -	- possible to store in surplus water(may-Oct), - effective conservation in existing ponds, tanks, reservoir, tubewell	-climate change (decrease in rainfall) -insufficient water in dry season, -waste product deposit on ground, creek and stream) -flooding
Economic	-Fair cost of YCDC water -acceptance of water bill	-high cost for dug Tubewell, -expensive cost buy water	- having many commercial activities & industries, - possible to low cost water supply system and distribution	-heavy cost of capital, maintenance, and operational of water supply options, including water distribution and storage
Risk-base	- less probability of supply shortfalls -fair maintenance and operational of water supply options	-Low lying flood plain, -salt water instruction in GW near River, -low in water quality, - GW contaminate near sewage and solid waste	-more ability to perform satisfactorily under a range of system changes(eg.climate) - less magnitude of failure duration	- climate change, - pond water dry up in late dry season, - over exploitation - decrease in aquifer & low water quality
Functional	-fair technical feasibility, -ability to use already available water infrastructure and monitoring water quality	-insufficient amount of YCDC water supply -less access supply water distance main pipeline -technical knowledge needed	- new water harvesting area, - upgrading distribution pipe line networks - new water supply project by YCDC	- growth urban infrastructure, - challenges with water supply management of site - aging infrastructure, water leakages and inadequate pipelines connection

Source: Field Observation

Suggestions and Conclusion

Although the inhabitants have adequate water in the rainy season, the majority have to rely on the City Water Supply System and groundwater. Therefore, strong concrete ponds should be constructed to store more rainwater to be able to offer quality water sufficiently in the dry season. The existing CWSS pipeline cannot deliver water effectively and thus each booster should be installed in each Township to enhance the flow of water. The quality of water delivered by the housing projects is unfavourably low and thus it should be treated before delivering. As such the authority concerned of the projects should build sustainable large concrete tank to store water and supply sufficiently. As the existing pipes have been laid out for a long time, lots of deposits are stuck in the inner walls of these pipes, decreasing the flow of water and also contaminating the water. Both tubewell water and pond water are high in turbidity. Such water is kept one or two

nights to get fairly clear water. Therefore, CWSS system should be extended to the wards that have no access to it. The solid wastes as well as liquid wastes are disposed indiscriminately around the ponds, beyond the house compound and beside the creek bank which enhance water pollution. Depending on different acquifers and the distance from the Ngamoeyeik Creek, the groundwaters withdrawn from tubewells are more or less high in iron, chloride, pH, alkalinity, sodium nitrite and hardness, higher than permissive level of WHO Standard and thus such water should be somehow treated or boiled before drinking. The Industrial Zone is located close to the bank of Ngamoeyeik Creek and most industrial wastes are released into the creek, contaminating the stream water and groundwater. The YCDC and the responsible persons of the Industrial Zone should find out the best means of disposing industrial wastes. The flooding of highly contaminated water in rainy season and inavailability of clean and safe water in the dry season increase the incidence of diarrhoea, bowel disorder, dysentery jaundice, typhoid and polio. To reduce such ill-health, the inhabitants cautiously treat the available water which is more or less contaminated with undesirable chemicals and pollutants. The existing concrete tanks in the housing projects are close to sewer tanks, decreasing the quality of water. The YCDC has instructed to chlorinate the water to somewhat improve the water quality. Consuming chlorinate water for long period may cause ill-health to the consumers. Therefore, the concrete tanks for storing water should be built away from the sewer tanks. Some households use very shallow sewer pit and thus the dirty matters degrade the environmental quality and surface water. Occasional educative talk should be launched to increase the awareness of hygienic and healthy lifestyle. With the increasing population, the number of tubewell has been increasing which can exhaust the existing aquifers in the long run. Therefore, the responsible persons should undertake effective arrangements to be able to provide clan, potable water to the inhabitants of the study area. The general trend is that population of the study area is likely to increase at the present rate (1.7%) and the majority would have to depend more on groundwater which is fairly low in quality, unless the YCDC shows concern over the water related problem in the study area and extend the existing CWSS pipeline system covering all the wards of the study area. Indeed, the real problem, for the time being, is not shortage of water, but inavailability of clean, safe and potable water in sufficient amount at low expense.

Acknowledgement

I would like to express gratitude to Dr. Htun Ko, Professor and Head, Department of Geography, University of Yangon and Dr Khin Sandar Aye, Professor, Department of Geography, University of Yangon for their encouragement during the preparation of my research. I am very grateful to special thanks officials and personnel of Yangon City Development Committee (Water and Sanitation Department), National Health Laboratory, Ward and Township General Administrative Office for their help in my research work.

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COMPARISON OF WATER QUALITY ASSESSMENT BETWEEN INLAY LAKE AND SAMKHA LAKE (SAMKHA INN), NYAUNG SHWE TOWNSHIP, SHAN STATE

Saw Yu May[1], Thida Soe[2]

Abstract

Increasing population and its related conditions are posing to the environmental degradation and causing contamination around the world, lake and reservoir are also included. Lake (Inn) is source of food for the local people, home for biodiversity, water recharge area for groundwater, etc. Inle Lake and Samkha Inn is situated in Nyaung Shwe Township, Southern Shan State. Although Inle Lake is formed naturally, Samkha Lake (Samkha Inn) is created by the construction of Myobye Dam, which are connected with lower Nam Belu Stream. The local people depend on these two lakes for their livelihood such as fishing, agriculture as a source of water. Population is increasing year after year; the quality of water might be more and more degradation in this area. Therefore, the research question is raised for this study, how are the quality of water in these two lakes due to human activities. The objectives of this study are to assess the status of water quality in Inle and Samkha lakes, to analyze the spatial and temporal variation of water quality in these two lakes, to support the information of water quality for conserving of these lakes in future and contributing of UN- SDGs. To fulfill the question of this study, water is tested on field measurement and laboratory test from these two lakes. Based on these results, the spatial and temporary assessment of water quality was done with the aid of GIS technique.

Keywords: *water quality assessment, Inle Lake and Samkha Lake, Nyaung Shwe Township, Shan State*

Introduction

Clean water is one of the most important things for all form of life including human and it assessment and monitoring is also crucial. Water quality assessment is the overall process of evaluation of the physical, chemical and biological nature of the water and water quality monitoring is the collection of the information (1996. UNESP, WHO, UNEP)

The Inle Lake, the second largest Lake in Myanmar, is one of the destinations for domestic and international tourism. Inle Lake became as a Biosphere Reserve Area UNESCOs Biosphere Reserve Area in 2015 and Myanmar's fifth Wetland of International Importance Ramsar Site in 2018 which is important for biodiversity as well as socioeconomic development of local people. According to the Davis et.al (2004), Inle Lake is one of the most important lakes in Southeast Asia for fish endemism; it has very high cultural and scenic values, high water plants diversity and is one of the highest located lakes in Myanmar.

In the lower part of the lake, the Belu Chaung (Belu Stream) flow down just a little distance and is created as Samkha Inn (Lake) due to construction of Myobye Dam for Lawpita Hydroelectricity Power Plant which is one of the important power plants in Myanmar. Sankha Lake (locally named as Samkha Inn) is also important for the local people for their livelihood and it is connected with Inle Lake with Belu Stream. It can be said that the water source is the almost the same with Inle Lake except two more streams entern to the Samkha Inn (Lake) Based on these facts, it is necessary to assess how relationship the water quality between Inle Lake and Samkha Inn. The conservation and protection of these lake is very important not only residents but also for visitors. At present, the water quality of lake water quality is impacted by human activities from

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the catchment area and within lake. Therefore, water quality assessment is necessary on these two lakes for aquatic ecosystem as well as socioeconomic condition of the local people.

Research Question and Objectives of the Research

It is therefore, the main problems of this study are could use to address the following basic question of "How does the water quality vary in Inle Lake and Samkha Lake due to human activities?" Therefore, the main purposes of the study area are to assess the status of water quality in Inle and Samkha lakes, to analyze the spatial and temporal variation of water quality in these two lakes and to support the information of water quality for conserving of these lakes in future and contributing of United Nations Sustainable Development Goals.

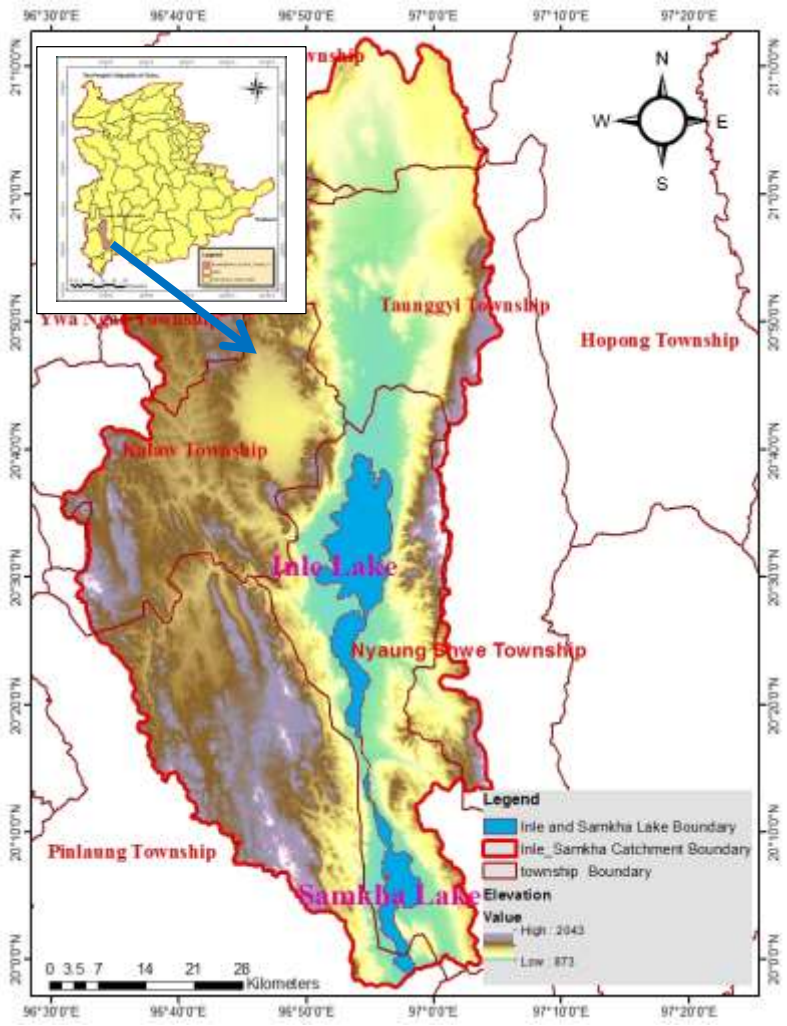
Methodology

To fulfill the research question, on field measurement and laboratory test was taken on the water quality from Inle Lake and Samkha Lake which were considered on different sample sites within these two lakes. Regarding with sampling sites, nine samples sites were selected for Inle Lake water quality and five sample sites for Samkha Lake in this study. The reasons for sampling sites were considered on inflowing water, outflowing water, the middle part of the lake, the settlement area, agriculture area, the starting point that entering to the lake from streams. In respect with choosing parameters, 14 parameters were decided to measure by human activities taking place in this area and water sample was measured and collected in April and October, 2018 and January 2019 for three seasons.

In term of field work, on field measurement was taken on the variables of pH, turbidity, EC, DO (Dissolved Oxygen), temperature and TDS (Total Dissolved Solid) for three layers (a: surface layer, b: one meter depth of the lake, c: the bottom of the lake). Moreover, lakes water were systematically collected with bottles and tested at the laboratory on the variables of Nitrate, Phosphate, Arsenic, Lead, Coliform which is assessed by WHO Drinking Water Quality and Portable Water Quality Standard. Based on these results, the spatial and temporal variation of water quality assessment of these two lakes was done with the help of GIS technique (interpolation Method) in this study.

Study Area: Inle Lake and Samkha Lake

Inle Lake and Samkha Inn Lake are situated in the Nyaung Shwe Township, Southern Shan State. It fall between Latitude 19° 58′ 0″ and 20° 43′ 05″ North, Longitude 97° 46′ 30″ and 97° 55′ 30″ East. Inle Lake is situated at the central part of the Nyaung Shwe Township, which is about 883.92 Meters (2900 ft.) above Mean Sea Level. Samkha Lake (Samkha Inn) is in the lower part of the Inle Lake which is connected with Belu Chaung (Stream). Figure1.



Source: Digitizing on UTM Map and DEM (Digital Elevation Model

Figure 1 Study Area: Inle Lake and Samkha Lakes, Nyaung Shwe Township, Shan State, Myanmar

In Inle Lake and Samkha , Occupy the central part of a trough between two mountain ranges which run from North to South direction and 1219.2 meters (4000ft) – 1524 meters (5000 ft) above Mean Sea Level. Of 29 streams which enter into the lake, 4 major streams are entering into Inle Lake (named Namlat, Thandaung, Inndein and Yepae Streams) but some are very short and some are dried up in the dry season, particularly from the eastern part of the lake and 2 main streams (named Nam Tin and Nam SinStreams) flow into Samkha Lake. In the watershed, there are five townships and their rainfall influence to the lake's and total annual rainfall is between 60'' (1524 mm) to 80'' (2032 mm). Similarly, the water via inflowing water and runoff to these two lakes as well as human activities from catchment area also influence to the lake water quality.

Findings and Discussions

As above mentioned, in order to obtain the status of water quality in Inle Lake and Samkha Inn Lake, 13 water quality parameters of physical, chemical and biological characteristics were chosen and 14 sampling sites were chosen by different reasons including inflowing, outflowing and main body of lake water. It was analyzed for variation of water quality for spatially purpose and three seasons for temporary changes within two lakes.

Among them temperature is varied with vertically in the lake. Generally, a layer is highest temperature in Inle Lake but b layer (1meter depth) is the highest temperature in Samkha Lake. The temperature profile was not significant because Inle Lake is a shallow Lake but Samkha Lake is a little deeper than Inlake Lake.

i. Spatial and Temporal Variation of pH Value in Inle and Samkha Lakes

In Inle Lake, the pH value is between 7.2 and 8.9. The highest value is found in Sample 2,3,4,7 and 8 which are the main water body of the lake due to being in limestone area in nature. The seasonal variation was not significant but inflow water quality is more alkaline than body of lake in Rainy Season. Similarly, the pH value was between 7.1 and 8.1 in Samkha Lake and there is no variation within seasonally. Therefore, it is no significant variation within these two lakes and acceptable level to compare with WHO drinking and portable water quality standard. See in Figure 3.

ii. Spatial and Temporal Variation of Conductivity in Inle and Samkha Lakes

In term of Conductivity (EC), it was not obviously varied spatially and the value was between 200 and 500 mg/L in Inle Lake, but it is fluctuation seasonally which was decreased in the Rainy Season and increased in the Hot Season and the Cold Seasons. In Samkha Lake the conductivity was a little bit higher than Inle Lake between 270 and 500 mg/L. Similarly with Inle Lake, Conductivity was high in Hot and Cold Season but it was low in Rainy Season but it was not much variation in spatially. WHO drinking water quality of Conductivity is between 0.15 mg/L and 15 mg/L and portable water quality is between 400 mg/L. Based on the analyzed data, all sample sites in Inle Lake and Samkha Lakes were beyond acceptable level of WHO drinking and portable water quality level particularly in Hot Season and Cold Season. See in Figure 3.

iii. Spatial and Temporal Variation of Total Dissolved Solid in Inle and Samkha Lakes

Total Dissolved Solid is an important parameter for the lake. Total Dissolved Solid is varied from 200 ppm to 300 ppm in Inle Lake which was decreased value in the Rainy Season but was increased in the Hot and the Cold Season. The highest was found in Sample 1 which is inflowing water in the Hot Season. In Samkha Lake, Total Dissolved Solid was varied between 180 ppm and 300 ppm there which can be said that the value was lower than Inle Lake where the sample 4 (inflowing water) was the highest. Therefore, Total Dissolved Solid is more significant in inflowing water from the catchment. To comparison with WHO drinking water quality (1.0 ppm) and portable water standard (50-1500 ppm), all the sample sites in Inle and Samkha Lake are beyond the drinking water quality but acceptable level for portable water quality. See in Figure 3.

iv. Spatial and Temporal Variation of Turbidity in Inle and Samkha Lakes

Similarly with TDS, Turbidity is also important parameter for Inle Lake. Turbidity was significantly varied between 3 NTU – 1000 NTU in Inle Lake, the highest Turbidity was found in Sample 1 and Sample 3 (inflowing water) in Rainy Season and deposited at the mouth of the stream. In all season, Turbidity was high in the western part of Inle Lake where there is delta accretion due to deposition process. In Samkha Lake, Turbidity was between 1 NTU and 100 NTU and the value was generally lower than Inle Lake. In addition, it was not much varied seasonally as well as spatially. WHO drinking water quality and portable water quality for Turbidity is 5 NTU and 25 NTU. Therefore, Turbidity is beyond the limit of WHO standard in some samples and some were acceptable range within these two lake. Figure 3.

v. Spatial and Temporal Variation of Nitrate in Inle and Samkha Lakes

Nitrate and Phosphate are important water quality variables for lake which indicate the level of eutrophication stage. In Inle Lake, the concentration of Nitrate was between 7 ppm and 19.6 ppm. The highest Nitrate concentration was found in Sample 1 and Sample 3, which are especially from inflowing water from catchment area. In Samkha Lake, Nitrate was between 8 ppm and 12 ppm which varied seasonally and spatially but the concentration was high in Rainy season. WHO drinking water quality standard, Nitrate is 10 ppm is acceptable and portable water quality standard, 50 ppm is permissible level. In these two lakes, Nitrate in the Rainy season was generally higher than Dry period. Based on the analyses of Nitrate concentration in Inle is higher than Samkha Lake because Inle Lake has bigger catchment and more human activities. See in Figure 3.

vi. Spatial and Temporal Variation of Phosphate in Inle and Samkha Lakes

The natural level of PO4 usually range in surface water is 0.005 mg/L to 0.05 mg/L. In Inle Lake, Phosphate is ranged between 0.02 mg/ L to 0.5 mg/L. In Inle Lake, the highest Phosphate was found in Sample 5 (inflowing water from the eastern part of the lake) in the Hot Season and Sample 9 (outflowing water) in the Rainy Season. But there is no phosphate content in the Cold Season. In Samkha Lake, Phosphate was varied from 0.02 mg/L to 0.04 mg/L which can be found almost in the Rainy Season and one sample in the Hot Season. Normally, Phosphate content in Inle Lake is higher than Samkha Lake but there is no Phosphate in the Cold Season within these two lakes. See in Figure 3.

vii. Spatial and Temporal Variation of Dissolved Oxygen in Inle and Samkha Lakes

Dissolved Oxygen is varied with collection time and aquatic growth condition. In Inle Lake, Dissolved Oxygen level was decreased in the Hot Season and it was increased in the Cold Season particularly in the b layer where Dissolved Oxygen was varied 1.24 mg/L to 40.24 mg/L. In Sam Kha Lake, Dissolved Oxygen was decreased in the Rainy Season and was increased in the Cold Season especially in b layer. Normally, Dissolved Oxygen was decreased in the Hot Season in Inle Lake because it is shallower than Samkha Lake. Figure 3.

viii. Spatial and Temporal Variation of Biological Oxygen Demand in Inle and Samkha Lakes

Biological Oxygen Demand is important for aquatic life in lake. Biological Oxygen Demand was ranged between 0 mg/L to 14 mg/L Inle Lake. But, in some sample was not found Biological Oxygen Demand value in the Hot Season and the value was normally high in the Rainy Season. Similarly, Biological Oxygen Demand was ranged between varied 0 mg/L to 19 mg/L in Sam Kha Lake which is almost found in the Rainy Season. Therefore, it can be said that Biological Oxygen Demand value was not much varied between Inle and Samkha Lake. See in Figure 3.

ix. Spatial and Temporal Variation of Chemical Oxygen Demand in Inle and Samkha Lake

In Inle Lake, Chemical Oxygen Demand was varied between 2 mg/L to 24 mg/L and the highest value is found in Sample 2, 8 and 9. Chemical Oxygen Demand value was varied spatially and seasonally in Inle Lake. In Samkha Lake, Chemical Oxygen Demand varied 3 mg/L to 14 mg/L, like Inle Lake, Chemical Oxygen Demand value in Samkha Lake was varied spatially and seasonally. WHO portable water quality standard for Chemical Oxygen Demand is 10 mg/L. Some samples site is beyond the limit of WHO standard in Inle Lake. For Comparison of Chemical

Oxygen Demand in these two Lake, the value in Inle Lake was higher than Samkha Lake. See in Figure 3.

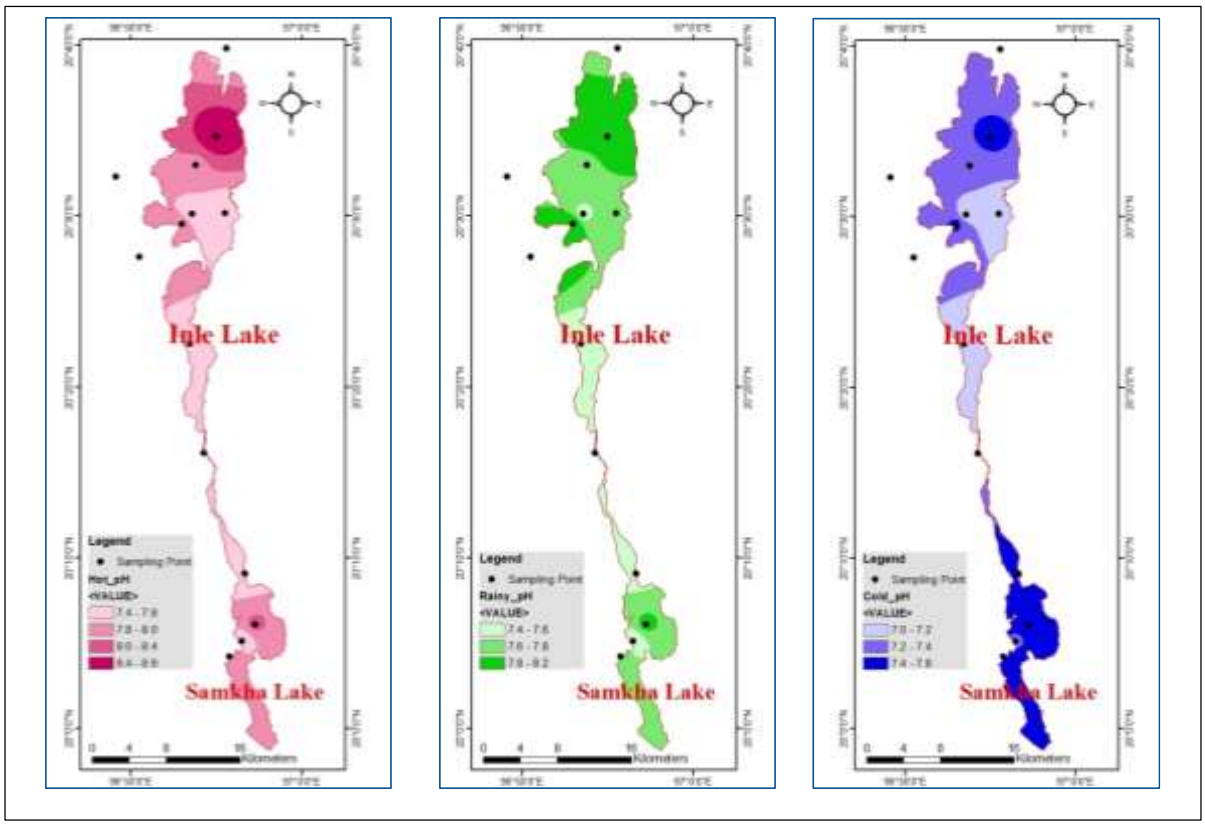
x. Spatial and Temporal Variation of Arsenic and Lead in Inle and Samkha Lake

In Inle Lake and Samkha Lake, there was no Arsenic content in every sample and every season. Likewise, there was no Lead content in every sample and every Season in Inle Lake and Samkha Lake. See in Figure 3.

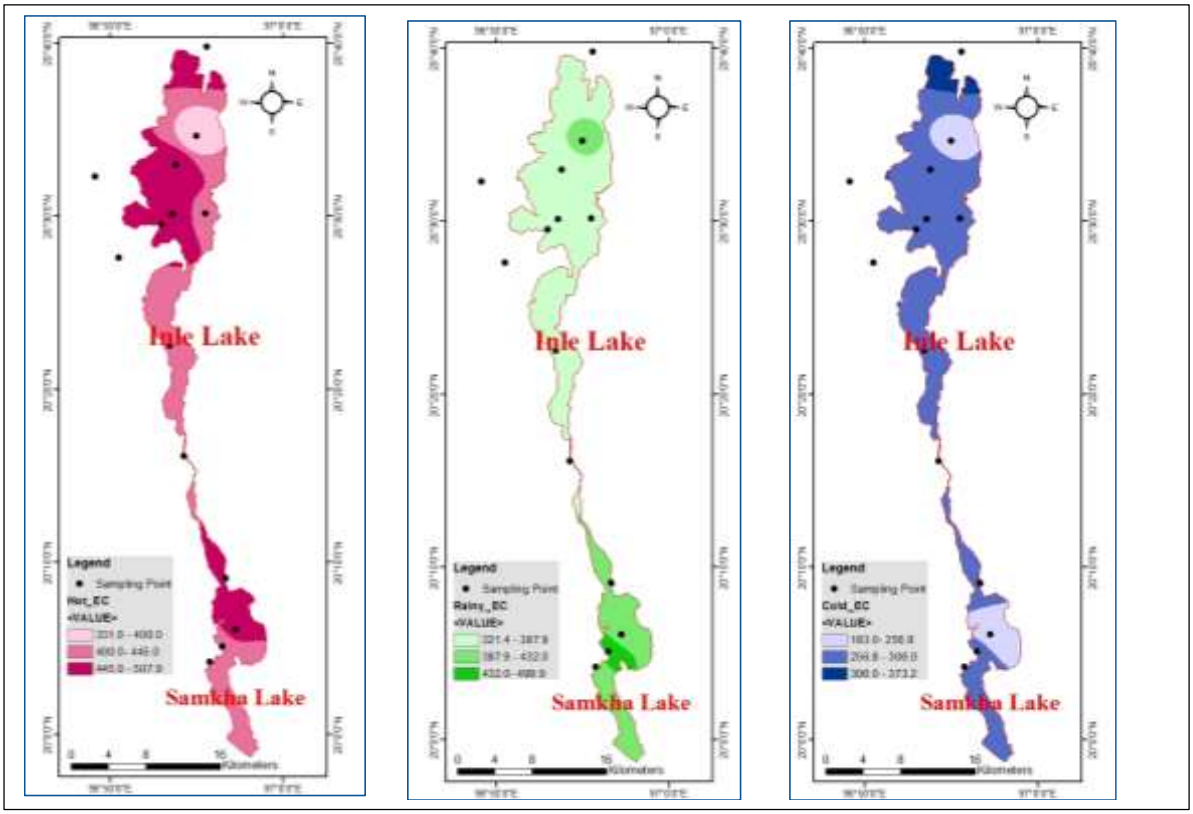
xi. Spatial and Temporal Variation of Coliform in Inle and Samkha Lake

Coliform is a biological characteristics in Water Quality Assessment. In term of Coliform variable in Inle Lake and Samkha Lake, it was found every sampling site. The amount is varied spatially and seasonally but it was normally high in the Hot Season. Based on the analyses on Coliform, Inle Lake is much more value than Samkha Lake due to more human activities and settlement in Inle Lake. WHO drinking and portable water quality is 1. Therefore, Coliform is beyond the WHO standard in all sample sites in Inle and Samkha Lake. See in Figure 3.

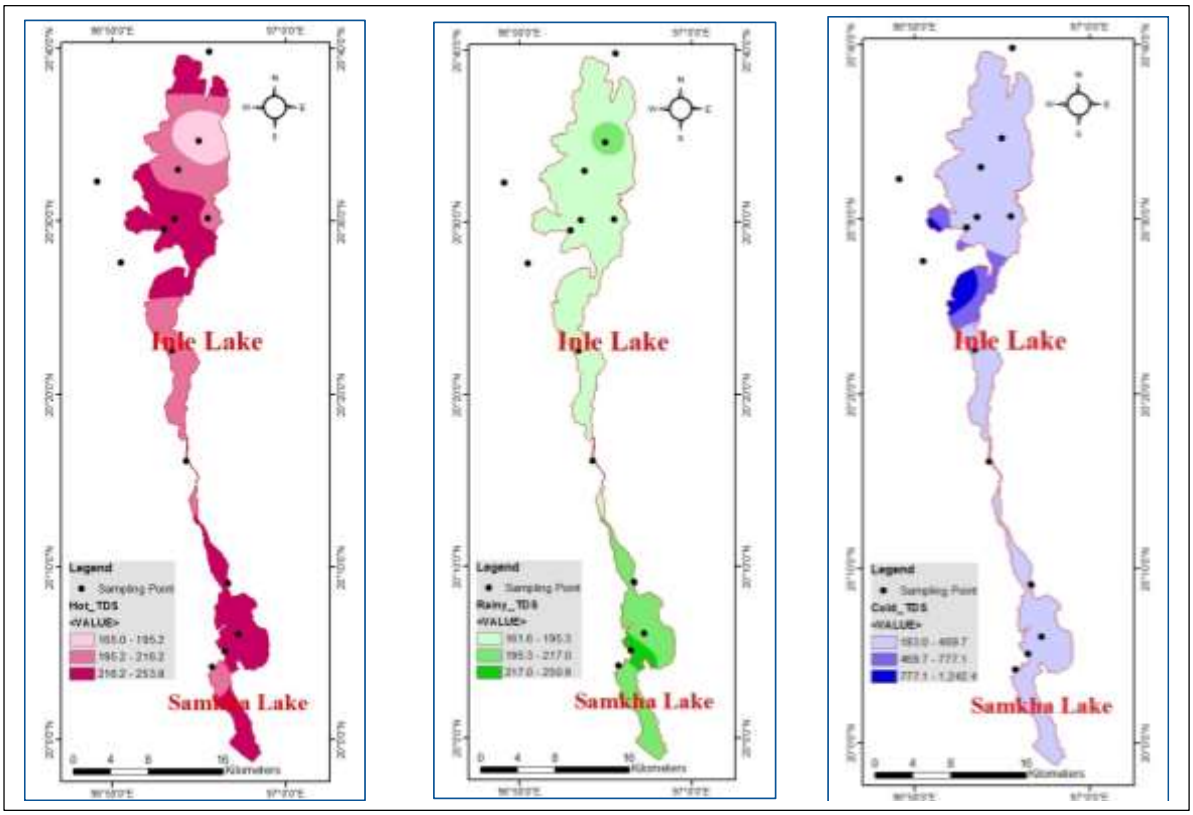
i. pH : for 14 samplings Sites and 3 Seasons



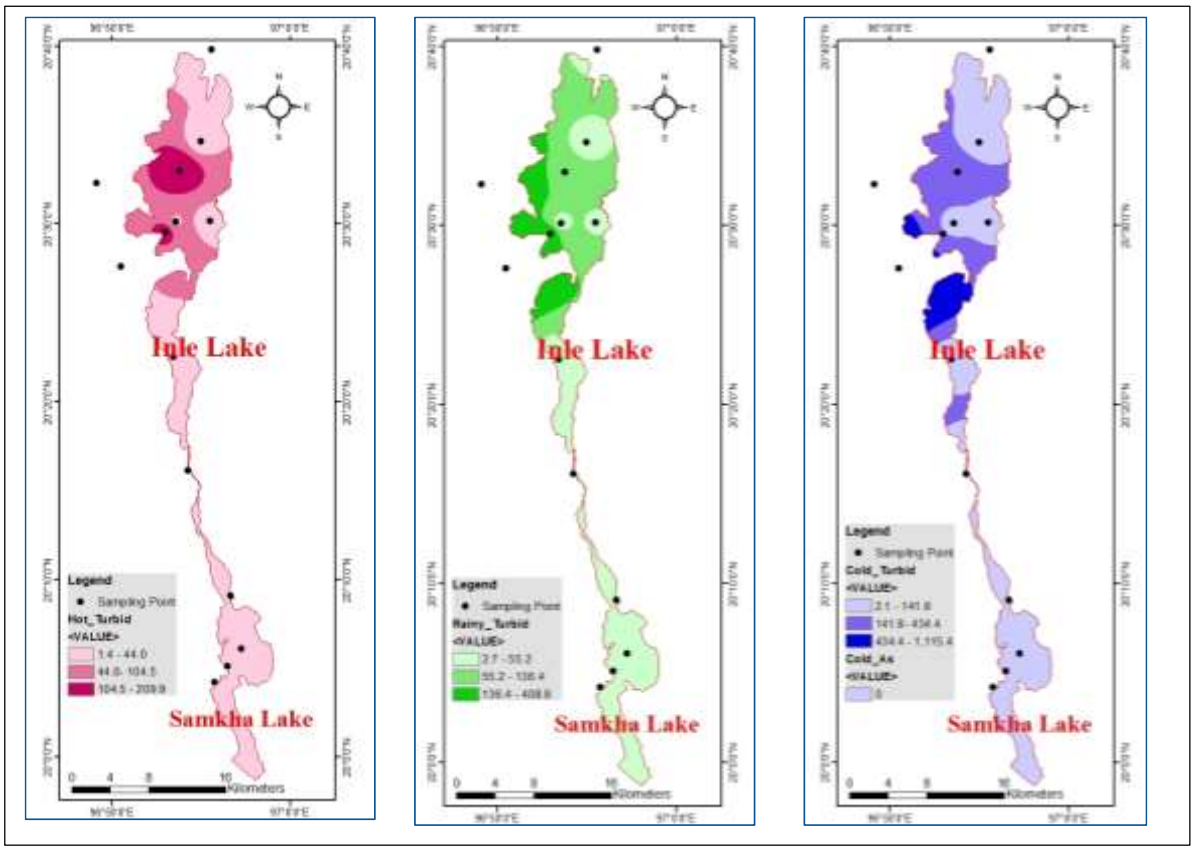
ii. Conductivity: for 14 samplings Sites and 3 Seasons



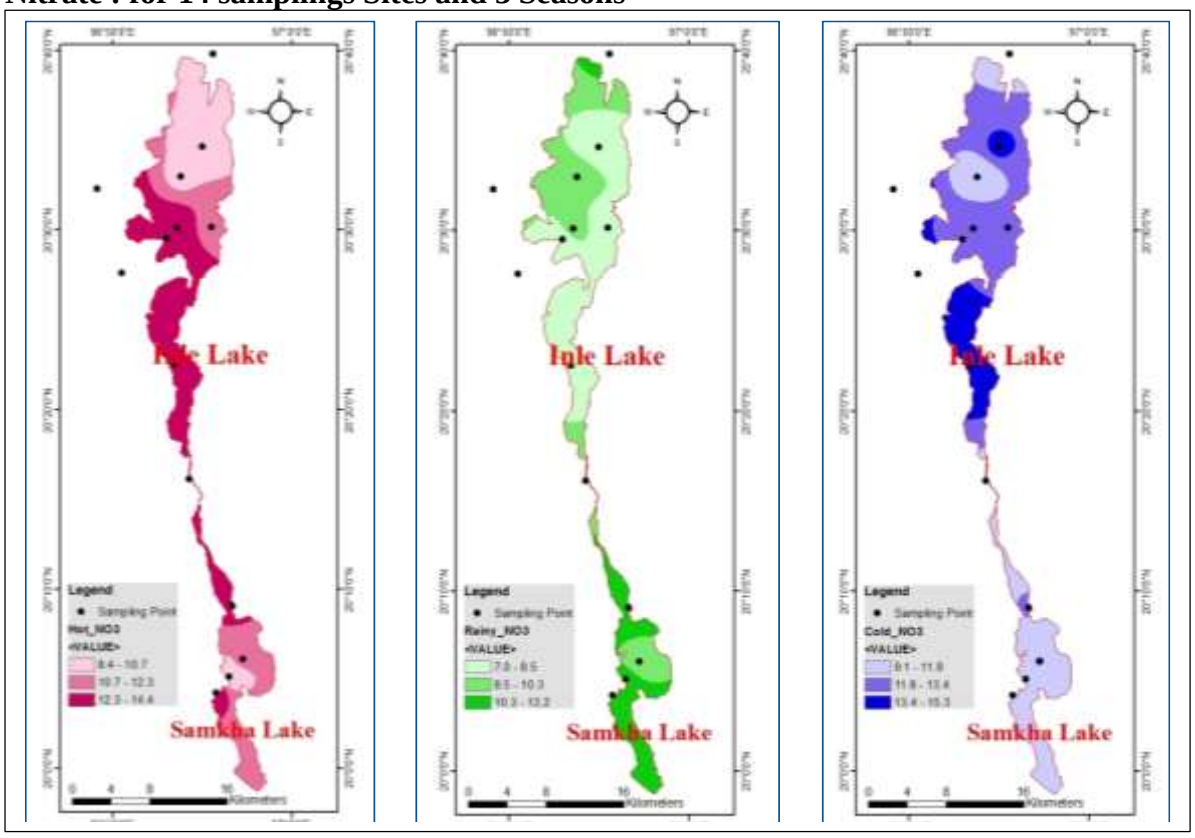
iii. Total Dissolved Solid (TDS): for 14 samplings Sites and 3 Seasons



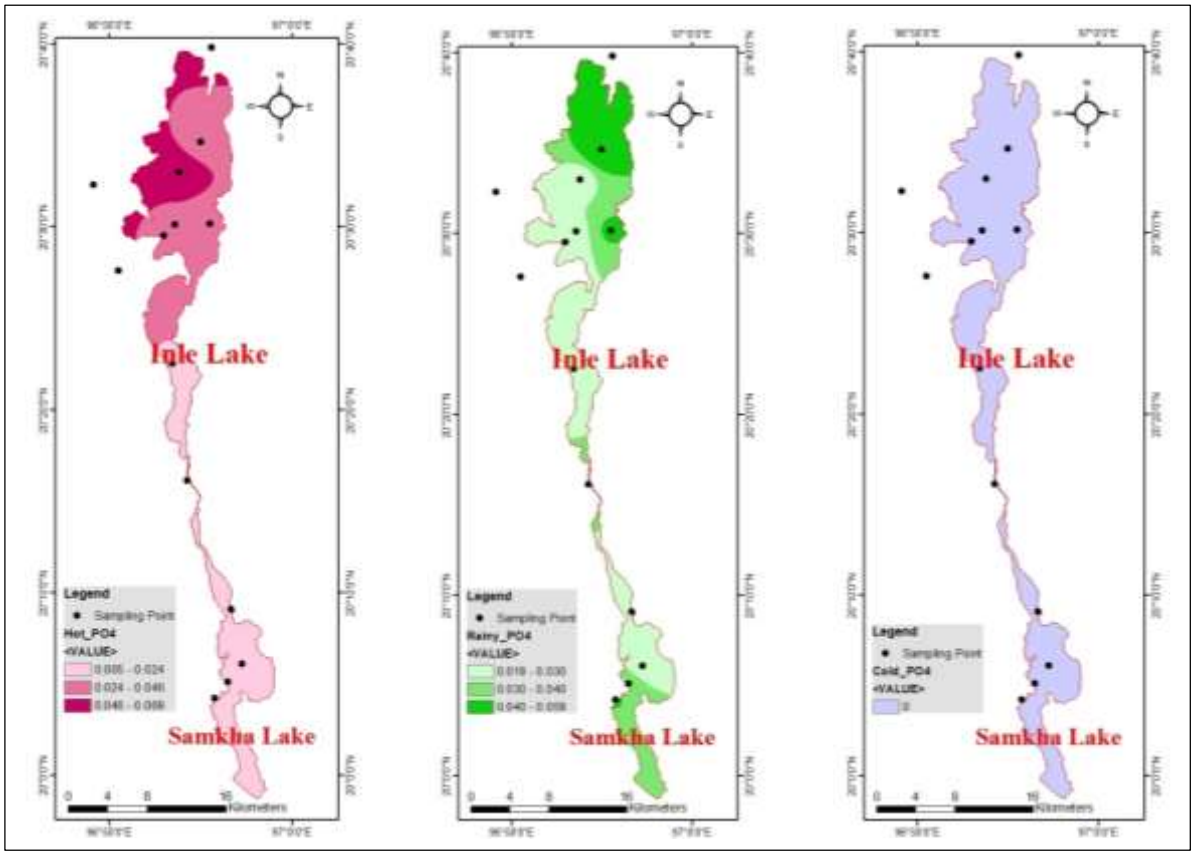
iv. Turbidity: for 14 samplings Sites and 3 Seasons



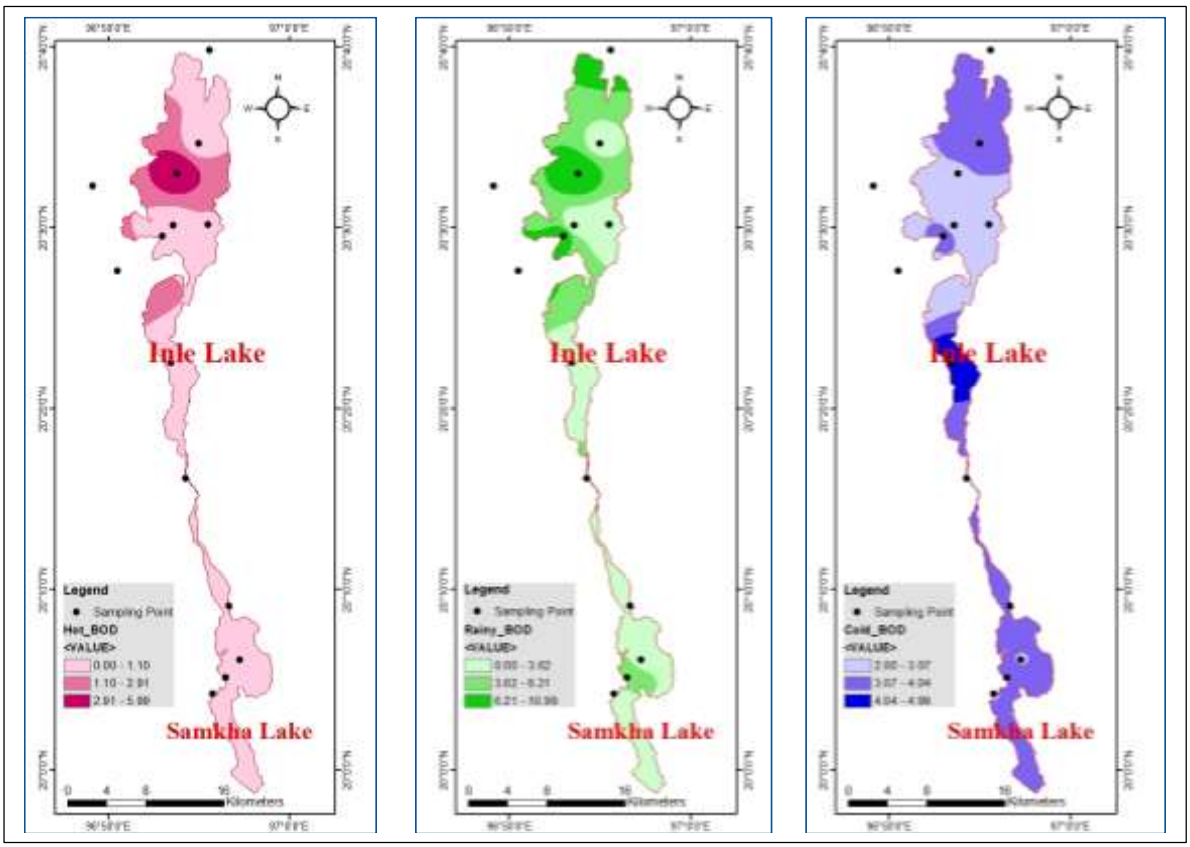
v. Nitrate : for 14 samplings Sites and 3 Seasons



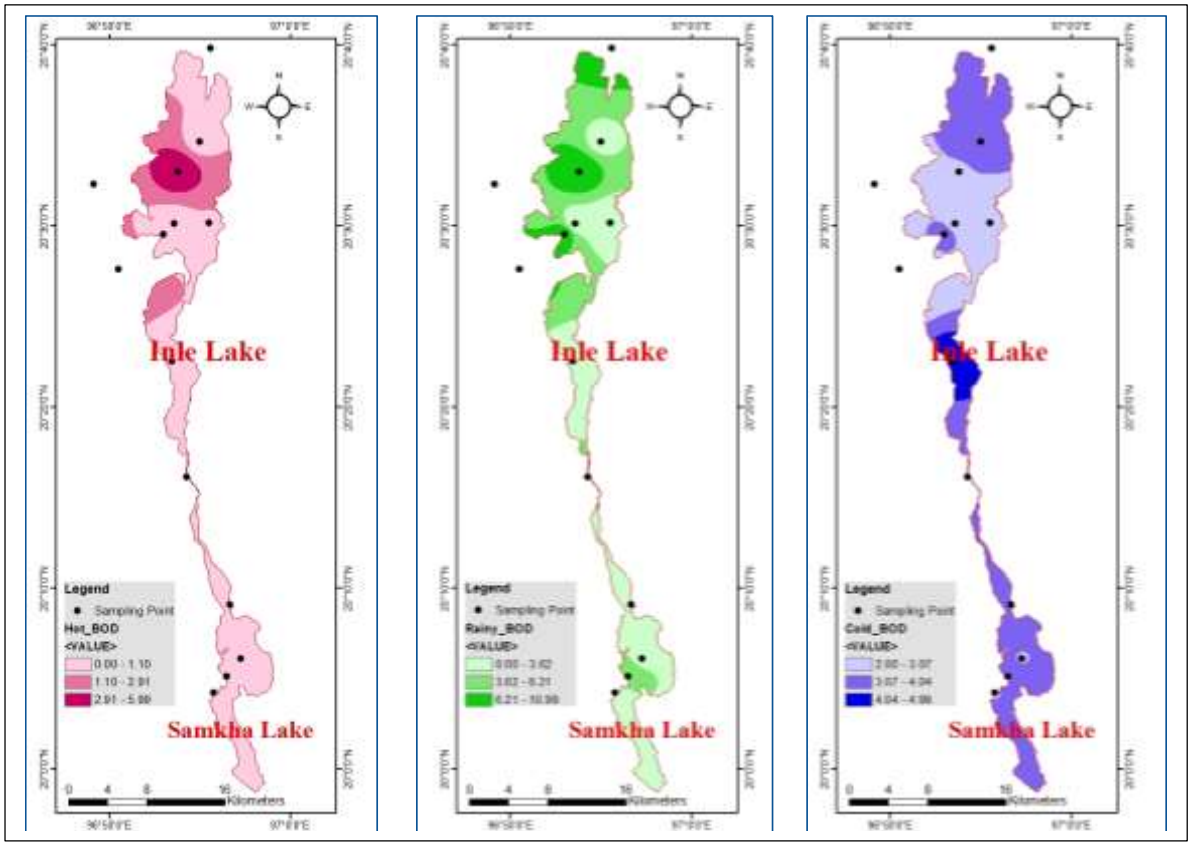
vi. Phosphate: for 14 samplings Sites and 3 Seasons



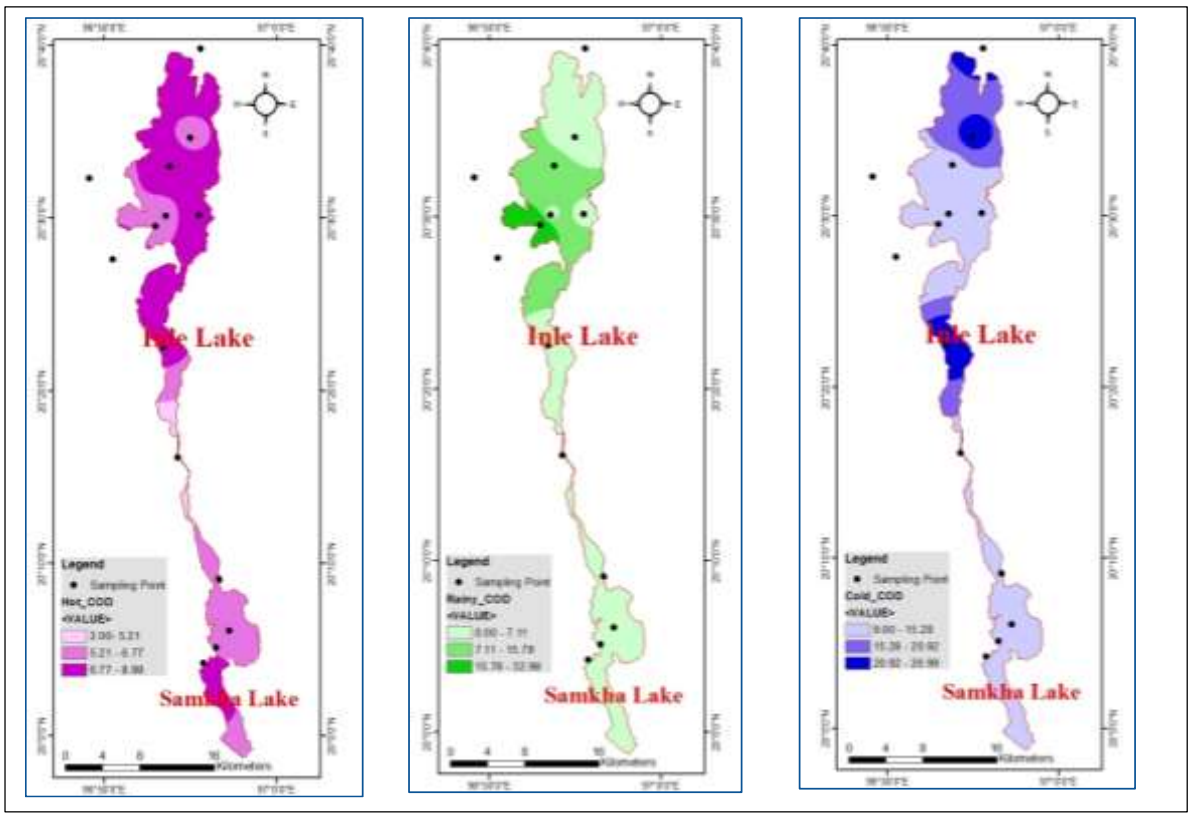
vii Dissolved Oxygen (DO): for 14 samplings Sites and 3 Seasons



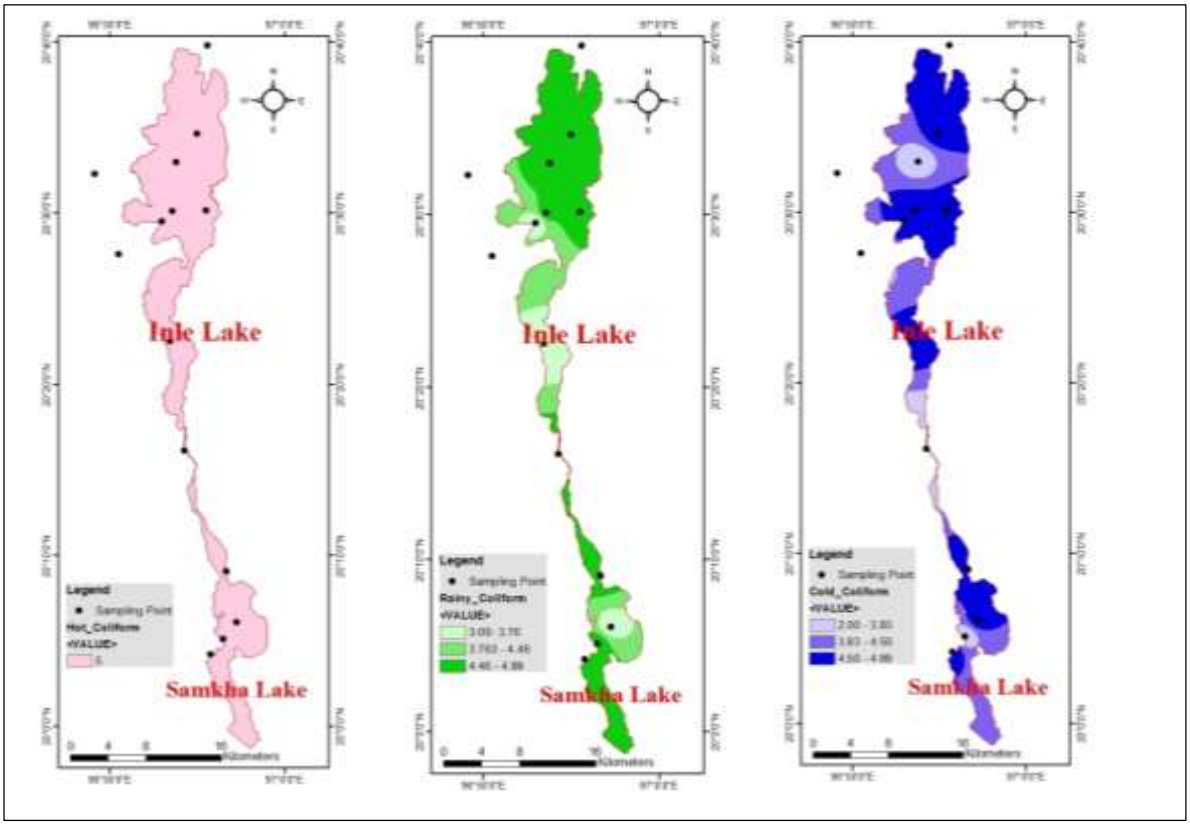
viii. Biological Oxygen Demand: for 14 samplings Sites and 3 Seasons



ix. Chemical Oxygen Demand (COD): for 14 samplings Sites and 3 Seasons



x. Coliform: for 14 samplings Sites and 3 Seasons



Source: Field Measurement, 2018

Fgure 2 Spatial Assessment of Water Quality in Inle and Samkha Lake

Table 1. Spatial and Temporal Water Quality Measurement in Inle and Samkha Lake

WQ	Season	I.S.1	I.S.2	I.S.3	I.S.4	I.S.5	I.S.6	I.S.7	I.S.8	I.S.9	S.S.1	S.S.2	S.S.3	S.S.4	S.S.5
Tem (°C)	Hot	26.3	27.2	23.3	26.4	27.7	26.6	23.8	25.8	25	27.4	26.6	26.3	25.2	27.4
	Rainy	24.8	25.2	24.1	24.1	25.1	19.8	26.2	21.2	28.3	27.1	26.7	26.2	24.2	26.2
	Cold	22.6	19	24.2	18.5	22.7	19.8	20.7	21.2	19.9	21.5	20.9	20.5	20.8	20.1
pH	Hot	7.65	7.56	7.48	7.85	7.92	8.06	7.7	7.61	8.04	8.11	7.53	7.53	8.04	8.04
	Rainy	7.57	8.12	8.4	7.85	7.61	7.37	8	7.8	7.84	7.97	7.58	7.44	7.4	7.6
	Cold	7.15	7.53	7.45	7.01	7.02	7.08	7.53	7.25	7.83	7.68	7.56	7.4	7.2	7.2
EC	Hot	405	484	427	331	494	388	426	560	515	420	450	479	441	420
	Rainy	224	366	360	364	378	388	375	401	383	393	389	400	500	374
	Cold	519	392	386	433	379	4.3	383	307	538	378	274	423	510	393
TDS	Hot	202	240	214	165	205	222	213	280	258	211	224	240	220	211
	Rainy	112	184	181	182	187	194	187	200	191	197	194	200	251	168
	Cold	364	277	274	307	269	286	272	218	382	268	183	300	305	279
Turbidity	Hot	7.43	34.8	13.1	6.57	210	138	10.2	12.3	5.91	3.79	4.69	32.6	1.48	3.79
	Rainy	1023	198	317	99.9	23.2	3.6	4.19	2.32	19.2	6.87	3.34	11	5.14	2.68
	Cold	1005	178	309	89.9	21.2	3.1	3.95	10.1	17.5	5.87	3.21	9.98	4.79	2.51
DO	Hot	6.45	5.56	6.5	7.2	7.0	1.27	8.02	8.1	6.99	7.4	7.6	18.8	2.9	7.6
	Rainy	7.9	7.54	8	6.3	6.6	1.27	1.85	8.14	6.99	0.18	6.35	0.1	0.12	6.5
	Cold	29.7	42.5	34.2	21.7	38.1	35.7	4.37	40.2	19.6	8.9	8.8	19.7	7.3	3.3

WQ	Season	I.S.1	I.S.2	I.S.3	I.S.4	I.S.5	I.S.6	I.S.7	I.S.8	I.S.9	S.S.1	S.S.2	S.S.3	S.S.4	S.S.5
NO3	Hot	11.2	7	7.7	9.8	7	9.8	7	7	11.2	13.3	8.4	12.6	11.2	9.8
	Rainy	17.5	12.6	15.4	9.1	11.9	13.3	15.4	14	10.5	9.8	11.9	11.9	10.5	11.2
	Cold	19.6	14	14	9.8	11.2	14	13.3	8.4	9.8	14	11.2	13.3	8.4	8.4
PO4	Hot	0.1	0.04	0.05	0.07	0.03	0.04	0.02	0.03	0.05	ND	0.02	ND	ND	ND
	Rainy	0.02	0.019	0.02	0.02	0.045	0.02	0.025	0.06	0.05	0.042	0.02	0.018	0.038	0.035
	Cold	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DO	Hot	6.45	5.56	6.51	7.22	6.59	1.27	8.02	8.14	6.99	7.35	7.55	18.8	2.88	7.35
	Rainy	7.9	7.54	8	6.3	6.59	1.27	1.85	8.14	6.99	0.18	6.35	0.1	0.12	6.5
	Cold	29.7	40.05	34.2	21.5	38.1	35.7	4.37	40.2	19.6	8.92	8.75	19.65	7.34	3.34
BOD	Hot	0	0	4	11	6	0	1	2	9	13	0	2	0	0
	Rainy	2	9	14	11	6	8	1	2	9	19	3	2	0	4
	Cold	2	4	6	3	2	2	3	4	4	3	3	4	4	3
COD	Hot	4	6.5	8	8	9	6	7	6.5	8	8	5.5	6	6.5	6.5
	Rainy	21	33	11	10	5	5	8	8	7	7	6	8	8	3
	Cold	2	10	5	14	9	8	27	24	24	14	14	12	10	14
Pb	Hot	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Rainy	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Cold	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
As	Hot	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Rainy	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Cold	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Coliform	Hot	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5
	Rainy	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5
	Cold	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5

Source: Field Measurement on April , October 2018 and January 2019

Findings and Conclusion

Based on the results from water quality measurement in Inle Lake and Samkha Lake, the water in Inle Lake and Samkha Lake are more alkaline in nature because they are situated in limestone area. The parameters of pH, Total Dissolved Solid (TDS) and Biological Oxygen Demand (BOD) value is almost the same condition. But, Turbidity, Nitrate (NO_3), Phosphate (PO_4), Coliform in Inle Lake is higher than Samkha Lake. The Conductivity (EC) in Samkha Lake was higher than Inle Lake. Lead (Pb) and Arsenic (As) was not found in two lakes. In Inle Lake and Samkha Lake, Nitrate (NO_3) amount is the highest in the Rainy Season, PO_4 was not found in the Cold Season, DO value is decreased in the Hot Season, Coliform is the highest in Hot Season. To Comparison with WHO drinking and portable water quality, Conductivity (EC), Chemical Oxygen Demand (COD), Turbidity, Coliform is beyond the limit of WHO portable WQ Standard.

When the average concentration of soluble inorganic nitrogen exceeds 0.30 ppm and the soluble inorganic phosphorus content exceeds 0.01ppm, algae populations may explode (1985, Oliver S.Owen). Nitrates usually indicate pollution by human or animal waste and fertilizer run-off. In case of extreme pollution, concentrations may reach 200mg/l. In lake concentration of nitrate in excess of 0.2 mg/l -1 tend to stimulate algae growth and indicate possible eutrophication conditions (1992, UNESCO, WHO, UNEP). Therefore, nitrogen and phosphate nutrients indicated that the algae population is under explosion and the lake is starting towards eutrophication. Normally, if Nitrate exceeds 0.03 mg/L and Phosphate exceed 0.01 mg/L, algae population may

explode. Therefore, the results from measurement in this study indicate that some sample sites exceed these condition, these lakes might be started to eutrophication.

All these above measurement represent spatial and temporal variation of water quality status in Inle Lake and Samkha Lake during 2018 and 2019 which will support to the conservation and sustainable development of these lakes in the future and contribute to the United Nations Sustainable Development Goals No. 6.

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For this study, I deeply appreciated and thanks to Sayamagyi Dr. Mi Mi Kyi for her time guiding, preparation, encouragement to me very patiently of this study. I also would like to express my grateful appreciation to my Master Students, Geography Department, Taunggyi University who were willing to helping me during field measurement. Thanks are extended to every person who helped in various ways.

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PROFITABILITY OF RICE FARMING PRACTICES: A CASE STUDY OF YANAUNGMYINE VILLAGE TRACT, DEKKHINATHIRI TOWNSHIP, IN NAY PYI TAW UNION TERRITORY

Thin Thin Myat*

Abstract

This research paper is primarily intended to investigate the relationship between local farmer practices and their farm input cost and return cost of rice production. Major objectives of this paper are; (i) to investigate the current farming systems in the study area, (ii) to observe and study the socio-economic characteristics of the selected farmers (ii) to assess and compare the household income and household expenditure (iv) to analyze how far farmers benefited from rice cultivation. Relevant data will be elicited from both the primary and secondary sources. Questionnaires and open interviews are the main instrument for data collection. Data analysis will be carried out using quantitative analyses, qualitative assessment and benefit cost ratio analysis. It is found that household expenditure, farmer's income and outcome are affected by different groups of each social characteristic of the selected farmers. According to the assessment, it is found out that backwardness, poverty stagnant agriculture, lack of alternative income and employment and environmental degradation are components of an integrated problem in the Village Tract. There is a need for enhancing employment and income generation activities in the study area. Revolution of the farming systems is a strategy for rural income growth and poverty reduction in the village tract.

Keywords: benefit cost ratio, household expenditure, farmer's income and outcome

Introduction

Nowadays, the government of Myanmar is trying to reduce poverty to fulfill its objective. Agricultural sector must be developed in Myanmar, 61.2% of population resides in rural area and are employed in the agriculture, livestock, and fishery sector (MOAI 2010). In Myanmar, there is a rice base farming system, and most of farmers are familiar with this system. The major source of income in rural areas comes from rice production. Therefore, rice production is a major source of employment, income generation as well as nutrition for rural households, and the growth of increasing rice production is extremely important in Myanmar. Rice is by far the most economically important food crop in many developing countries, providing two third of the calorific intake of more than 3 billion people in Asia, and one third for nearly 1.5 billion people in Africa and Latin America (FAO 1995a).

Study Area

Yanaungmyine Village Tract is one of the Village Tract in Dekkhinathiri Township in Nay Pyi Taw Union Territory (Dekkhinathiri District, Mandalay Region). In the south and east is Lewe Township, in the west is Dekkhinathiri Ward and in the north is Hotel Zone (Figure.1). The total area of Yanaungmyine Village Tract is estimated to be about 39.601sq km (15.29 square miles). In 2011 January 20, Dekkhinathiri Township is established with 2 wards, 8 Village Tract and 28 villages by the Republic of the Union of Myanmar Ministry of Home Affairs. In 2013 November 3, Dekkhinathiri Township changed and established with 2 Wards, 7 Village Tract and 22 Villages by the Republic of the Union of Myanmar Ministry of Home Affairs (Figure 1).

Aim

The aim of this paper is,

- To study the local people (farmers) status in the study area

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Objectives

Major objectives of this study are;

- to investigate the current farming systems in the study area,
- to observe and study the socio-economic characteristics of the selected farmers
- to assess and compare the household income and household expenditure
- to analyze how far beneficiary farmers benefited from rice cultivation

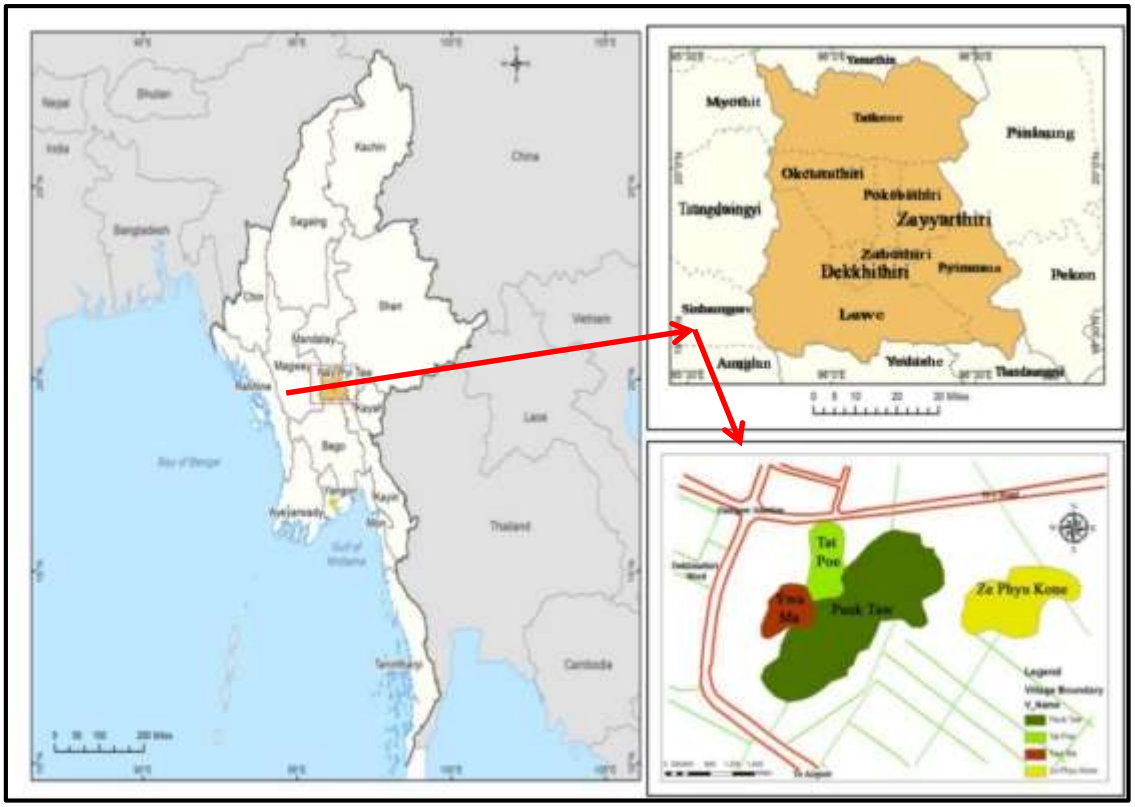
Methodology and Sources of Data

A multi-methods approach was used in this study, that was both qualitative and quantitative methods of data collection and analyses were used to address the research questions. Qualitative data techniques were used to address the selected village tracts (includes 4 villages). Purposive sampling methods were used to select households in rice production. Total of 134 sampled farmers including 118 males-headed households and 16 female-headed households were interviewed. They are 20 male-headed households and 4 female-headed households from Yawa Ma Village and 42 male-headed households and 6 female-headed households from Pauk Taw Village and 28 male-headed households and 2 female-headed households from Tat Poe Village and 28 male-headed households and 4 female-headed households from Zi Phyu Kone Village. The household level survey was carried out in each four villages in Yanaungmyine Village Tract, Deikkinathiri Township within Nay Pyi Taw Union of Territory (Figure 1).

Socio-economic characteristics of sample rice farmers such as material status, age, education level, farming experience, family size, annual household income as well as crop income, off-farm income, non-farm income, household assets and farm implements were collected. And also cultural practices of production such as rice production area, seed source, varieties used, seed rate per acre/hectare, annual husbandry, and utilization of fertilizer, seed, and pesticide were collected. Moreover, cost and returns of production of male and female-headed households were also included in data collection.

Quantitative techniques are typically used in deductive strategies of inquiry, and were helpful in understanding the usefulness of an intervention. Survey questionnaires were used to gather the primary data on the sample population, and are used in the analysis of the study area.

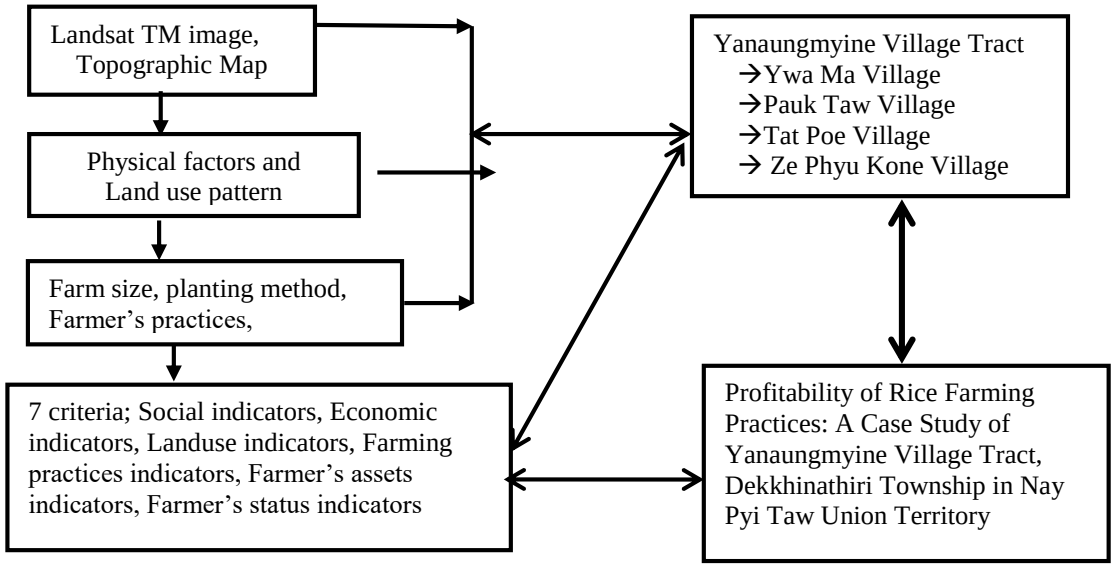
After that, this study analyzed physical conditions, human factors and agricultural practices within Yanaungmyine Village Tract, Dekkhinathiri Township in Nay Pyi Taw Union Territory (Mandalay Region) and it was investigated by using the secondary data. Major sources of the secondary data were collected from the Settlement and Land Records Department, the Ministry of Agriculture and Irrigation, and Township Peace and Development Council. The actual practices and agricultural conditions of the farmers are emphasized by using the primary data, which were gathered by using questionnaires, open interviews and field observations (Figure 2).



Source: Based on Google Map, 2020

Figure 1 Location of the Study Area (2020)

For data analysis, quantitative analysis and qualitative assessment were used to express the local farmers' agricultural practices and agricultural conditions in Yanaungmyine Village Tract, Dekkhinathiri Township in Nay Pyi Taw Union Territory (Mandalay Region). Moreover, the analytical techniques used in this study area were the descriptive analysis, and it was applied to describe and compare the socio-economic conditions, input use, farmer assets, farmer household expenditure, yield, existing farming practices and income of sample selected local farmers.



Source: Author, 2020.

Figure 2 Work Flow of the Study Area

The first analysis method was the difference between the total gross benefits or total returns and total variable cash costs, excluding opportunity costs. This value was referred to as "return above variable cash cost". The second analysis method was the deduction of the opportunity cost and total variable cash costs from gross benefit. This return was referred to as "return above variable costs" or "gross margin". The "return per unit of capital invested" could be calculated by gross benefits per total variable costs. The "return per unit of cash cost" could be calculated by gross benefits per total cash costs. These analysis methods could be expressed with equations as:

Method (1)

Return above variable cash cost = Total gross benefit – total variable cash cost

Method (2)

Return above variable cost (Gross margin) = Total gross benefit – total variable cost

Method (3)

$$\text{Return per unit of capital invested} = \frac{\text{Total gross benefit}}{\text{Total variable cost}}$$

Method (4)

$$\text{Return per unit cash cost} = \frac{\text{Total gross benefit}}{\text{Total cash cost}}$$

Research Question

How can the farmers' knowledge and their current farming systems guide their household income and outcome in the future of Yanaungmyine Village Tract, Dekkhinathiri Township in Nay Pyi Taw Union Territory?

Finding and Discussion

Rice cultivation is the most important factor in the study villages. In addition, the soils of the selected land should be fertile because poor fertility gives low yield. Population distribution in Yanaungmyine Village Tract is also related to agricultural lands. The most intensive use of land for agriculture is found mainly in the populated village tracts. The predominant ethnic group is Bamar and most of the Bamar people, traditionally, engaged in agriculture and its related works especially rice/paddy cultivation.

The Evolution of Farming Systems within Yanaungmyine Village Tract

In the previous years, traditional cropping systems and farming techniques were still important in the study area although some farmers adopted mechanization in their farms. Crop management practice was the main factor of cultivation of rice (paddy). Rice can be grown through broadcasting or by transplanting. For seed multiplication, it is desirable to grow rice under transplanting systems. Growing crops by transplanting method is supported by nurseries. Seedlings used for growing transplanted crop is raised in nursery, in which several systems are prevalent. For seed multiplication, wet system of nursery growing is recommended by agricultural offices and farmers. Fertilizer is used well before final pudding. The nursery is managed by proper top-dressing, watering and weeding to produce healthy seedlings, which assure good crop and high yield potential. Excess water is drained off, if it is flooded due to heavy rains or irrigation. Sowing of early and medium duration varieties in the nursery should be done in the period from the first week of May to mid-June.

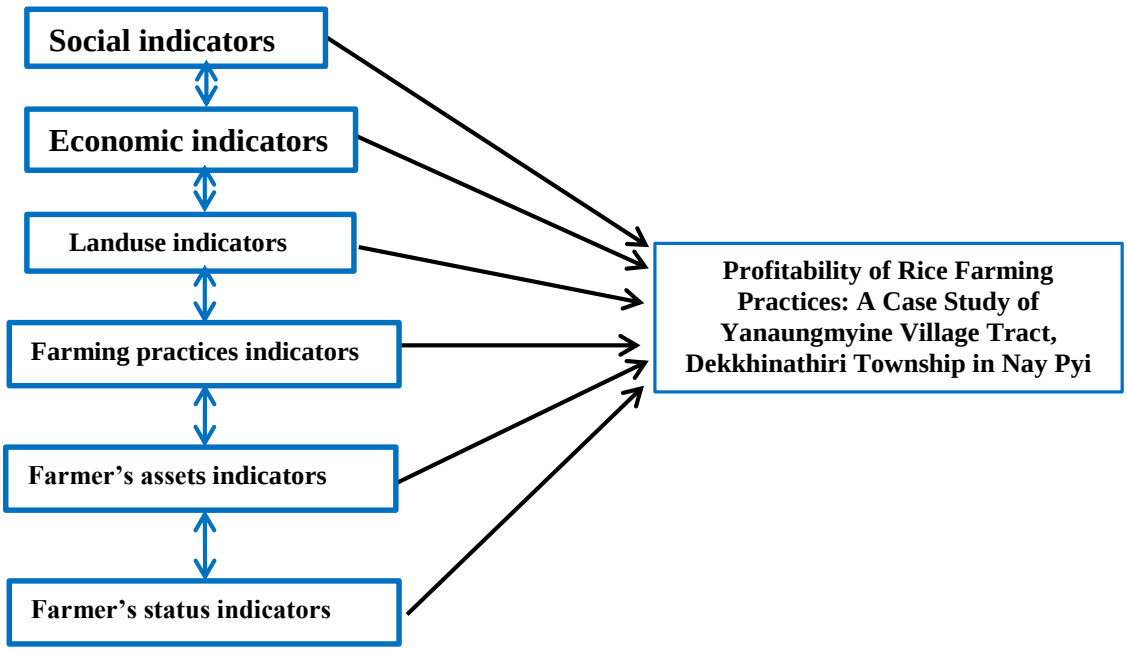
Seedlings become ready for transplanting after 3 to 4 weeks of sowing, depending upon the variety. The seedlings are uprooted gently. The rootless, weed, diseased, or those seedlings differing in any way from the usual characteristics of the variety under multiplication are discarded in the nursery.

The land should be prepared well by two to three ploughings followed by leveling. Poor field condition leads to failure or poor survival growth during seedling establishment and vegetative crop growth stages. Timeliness and good land preparation assures good yield of a crop. Poor land preparation may also lead to serious weed infestation. Land leveling allows maintenance of a uniform water depth and greatly facilitates subsequent management practices for establishment of stand, top-dressing with fertilizers, weed control, and field drainage for harvest.

In recent years or after 3 years, government encouraged the use of machines instead of traditional use of cows and buffaloes for nursery, transplanting, ploughing and threshing in their fields. Small-scale farm tractors are widely used in the study area with the aid of government. Therefore, rural agricultural activities in the study area, of Dekkhinathiri Township, depend on government policies and the market conditions of agricultural products. Agriculture was the main economic activities in these sample village tracts. These sample village tract has 4 villages; Pauk Taw, Tat Poe, Ywa Ma and Ze Phyu Kone villages.

Conceptual Framework of the Study area

The conceptual framework of the study area was shown in Figure 3. It was included six variables such as social indicators, economic indicators, landuse indicators, farming practices indicators, farmer's assets indicators and farmer's status indicators. The general conceptual framework of this study was framed on the participation of local farmers within four villages in Yanaungmyine Village Tract, Dekkhinathiri Township. In this framework, farmers whether participation which impacts on rice or paddy cultivation. Rice or paddy cultivation would be correlated by their six indicators such as age, education level, farm size, family size and assets and etc. Not only social indicators but also economic indicators would be related to farmer status Figure 3.



Source: Author, 2020

Figure 3 Conceptual Framework of the Study area

Historical Background of Agricultural Factors affection upon the Study Area

Yanaungmyine Village Tract lines between Nay Pyi Taw Union Territory and Lewe Township main road. In 2008, Yanaungmyine Village Tract was a big village with an area of 16,022 acres (25.03 sq. miles) and comprised of seven small villages. There were 520 households and total population with 3,568 persons in Yanaungmyine Village Tract. There were 335 farmers in Yanaungmyine Village Tract. In the total village tract area, agricultural land was 3188 acres comprising 2,372 acres of rice fields, 815 acres of Ya (dry farm) lands and 1 acre of garden land in 2006-2007. Therefore, farmer-agricultural ratio was 1:9. Main crops were: monsoon paddy, summer paddy, sesame, groundnut, Black gram, chili, vegetables, and fodders. (Thin Thin Myat,2008)

At present, Yanaungmyine Village Tract was a village with an area of 16,022 acres (25.03 sq. miles) and comprised of four villages. There were 1,195 households and total population with 3,503 persons in Yanaungmyine Village Tract. There were 182 farmers in Yanaungmyine Village Tract. Therefore, farmer-agricultural ratio is 1:9. Main crops were: monsoon paddy, summer paddy, Black gram, chili, vegetables, and fodders. According to 2019 data, farmers were decreased from 335 to 182 farmers because of new urban extension (Nay Pyi Taw Union Territory). Moreover, agricultural land was also 2,372 acres of paddy fields decreased to 1,101 acres of rice or paddy fields. Main crops were: monsoon paddy, summer paddy, black gram, sesame, groundnut, chili, vegetables, and fodders.

Most of the respondents practiced the transplanting method (96.1 percent) in monsoon paddy and direct seeding method (97.2 percent) in summer for crop establishment. The seeding rates of monsoon and summer rice cultivation are 2 bsk per acre, 2 or 2.5 bsk per acre, respectively.

Table 1 House Hold Conditions of Yanaungmyine Village Tracts (2019)

No	Village	Houses	Household	Farmer
1	Pauk Taw	553	553	71
2	Tat Poe	289	291	41
3	Ywa Ma	165	167	36
4	Ze Phyu Kone	184	184	34
	Total	1191	1195	182

Source: Landuse Department, Dekkhinathiri Township (2019)

Table 2 Farmers of Yanaungmyine Village Tracts in Dekkhinathiri Township

Village Tract Name	Popilation			Farmers	Farmers (Return Q)
	Male	Female	Total		
Pauk Taw	787	865	1652	71	48
Tat Poe	322	348	670	41	30
Ywa Ma	278	312	590	36	24
Ze Phyu Kone	287	304	591	34	32
Total	1674	1829	3503	182	134

Source: Field Survey Data, 2019

Rural Poverty Definition

Rural poverty refers to poverty in rural areas, including factors of rural society, rural economy, and political systems that give rise to the poverty found there. Rural poverty is often discussed in conjunction with spatial inequality, which in this context refers to the inequality between urban and rural areas. Both rural poverty and spatial inequality are global phenomena, but like poverty in general, there are higher rates of rural poverty in developing countries than developed countries. (https://en.m.wikipedia.org/wiki/Rural-poverty)

Poverty is not having enough material possessions or income for a person's needs. Poverty may include social, economic, and political elements. Absolute poverty is the complete lack of the means necessary to meet basic personal needs, such as food, clothing, and shelter. (https://en.m.wikipedia.org/wiki/Rural-poverty)

Rural Income Growth and Poverty Reduction of Yanaungmyine Village Tract

The rural poor have little land or landless, schooling or other assets, and face many interlocking barriers to go out from vicious cycle of poverty. Rural anti-poverty policy focused only on increasing the productivity of the poor would be not enough if public spending on education and health for urban receives more than rural areas. In general, poor people living in rural areas share several characteristics including low levels of educational attainment, a relatively large number of children, and relatively low access to material resources, weak social, and physical infrastructure, and higher susceptibility to community wide exogenous shocks. The problems of malnutrition, lack of education, low housing condition are more severe in rural areas.

The poor often have distinctive source of livelihood. It is common for the poor to work as cultivators, small artisans, petty traders and wage laborers. Agriculture is the main source of income both for the self-employment that is highly seasonal or part-time. People who live in or close to a state of poverty often experience significant fluctuations in their income or consumption particularly for rural poor of developing countries. When examining country where rural incomes from agriculture fluctuate, one should therefore use household or individual expenditures to access poverty in more reliable way.

By construction the poverty profile, the characteristics of the different socio-economic income or consumption groups such as very poor, poorer and poorest can be compared and analyzed. The poverty profile can provide the information on the identity of the poor along with their occupations, education level, age, household structure, dependency ratio, land holding, head of household, housing, access to the social services, and institutional networks. This will allow for a better understanding of who are poor and poorer, and what are the differences between the poor and poorest. Then further statistical analysis can be applied to test the relationship between the household consumption and the various characteristics of the poor and non-poor.

According to survey in the study area, the consumption of rice by each family in the survey was 1.6 Baskets per month for average 4 member families and 2.75 Baskets per month for average 8 member families. And also, the consumption of oil by each family in the survey was 1.5 viss per month for average 4 member families and 3 viss per month for average 8 member families. Similarly, the consumption of vegetable for each family cost 15000 kyat per month for average 4 member families and 30,000 kyat for average 8 member families. Typical Myanmar household in the central area consumed rice sauce as a source of a protein in their diet. It was consumed every day especially in central area where local raw (food) material was abundant. But, from nutritional point of view, food intake of rural families was found slightly lower than what was needed to have a reasonable healthy life. The average total cost of meat per family of 4 members (adult) per month was 24,000 kyat, 8 members (adult) per month was 48,000. Meat cost per person per month is 6,000 kyat on the average. It can be interpreted as optimum requirement of income per person per

month. Other cooking material total cost per month is 9,000 and 1,000 kyats. The cost per household was 66,576 kyat per month and 798,912 kyat per year or 133,152 kyats per month and 1,597,824 kyats per year.

Table 3 Total Cost of Optimum Level Meals for 8 Member Families per Day

Food Item	Unit	Amount	Value (MMK)
Rice (Stable food)	Basket	2.75	36,652
Cooking Oil	Vises	3	9,000
Meats (Daily)	Vises	16	48,000
Vegetables (Daily)	Tickles	30 to 90	30,000
Fish Paste, Extract, Salt	Vises	1 to 2	5,000
Onion	Tickles	2 to 3	1,500
Fuel Wood	Vises	10	3,000

Source: Field Survey, 2019

Farmers do not worry they manage to store enough paddies for their own consumption as long as they have rice, which was the staple food. Dishes of meat or fish were not so important. They can even have their meals with fish sauce and vegetables in case of food/income shortage (Table 3).

Diet comprises of carbohydrate from rice, animal protein from fish sauce and vitamins from vegetables. Minimum requirement of food for 8 member family cost 845 kyat per month. It costs 120 kyat per person per day. For the entire household it will cost 133,152 kyats per month and 1,597,824 kyats per year.

The Role of Labour Income Growth

During the last decade, the increase of labour income per worker-more than an increase of employment has contributed the most to poverty reduction (Inchauste et.al., 2014).

Structural information also strengthens rural-urban linkages in terms of production and markets, as well as rural-urban labour mobility, while fostering the growth of secondary and peri-urban cities. Agricultural transformation is both a case and effect of structural transformation, involving the shift from primarily subsistence farming to market-oriented and diversified production systems (FAO, 2017a).

This study area was based on primary source of data and they were collected from rice producing farmers with structured interview questionnaire and open interviews. The types of data were collected or selected according to the following criteria; age, farm size, family size, cropping pattern, land holding, education, use of mechanization, use of labour, etc. Technical data concerning with the rice production and constraints encountered by farmers in rice production, state of extension access, technology access and crop with higher profit were then collected. Economic data such as cost of production cost of labour, income from farm and non- farm, expenditure of food, shelter, clothing, social and education were also collected from each respondent. Farmer groups were categorized as low income farmers (n=39), medium income (n= 80), high income (n=15). Farmers with household per month income of greater than 3,000,000 was defined as high (11 percent) and 3,000,000 were categorized as medium income (60 percent) and farmers with income below 35,000 were low income farmers (29 percent).

Four Villages (one village Tract), were randomly chosen in the study area. They were Pauk Taw, Tat Poe, Ywa Ma and Zi Phyu Kone Villages from Yanaungmyine Village Tract in

Deikkinathiri Township, Nay Pyi Taw Union Territory. Most of the farmers depended on rice and winter crops for their livelihood. Some of the farmers in the study area were depended on their other family member such as government staff, company staff and other works.

Information on Selected Farmers

Social characteristics of sample farmers, farm size, sown acreage (monsoon rice and summer rice acreages), ownership of farm implements and machineries, luxury assets, cost and return of rice production, total income and expenditure of sample farmers, and share of income and expenditure are presented. The information will help in understanding the farmer's socio-economics condition in relation to their income and expenditure situation of monsoon and summer rice growing farmers in the study area.

In this study area, most of the respondents were average of 50 years of age ranging from 28 to 78 years. Majority of the sample farmers had low level of education (79 percent) and while 21 percent of sample farmers possessed high level education. The average family size was 6 ranging from 2 to 13 members. The average family labour in the farm was 2 with the range of 1 to 9. The average farm size was 9 acres ranged from 1.0 to 12 acres (Table 4).

Table 4 Social Characteristics of Selected Farmers in the Study Area

Items	Unit	All	Income Group		
			Low	Medium	High
Age	Year	50	50	51	49
Farm Size	Acre	9	3	8	17
Family Size	Number	6	5	6	7
Family Labor					
Education					
-Low	Percent	79 %	82%	83%	60%
-High	Percent	21%	18%	17%	40%

Source: Field Survey 2019.

Household's assets by Farmer income were shown in Table 4 In farmer assets, about 31 of sample farmers hand tractor and 10 households owned threshers and 57 households possessed water pump for irrigation. About 26 households possessed bullock cat. Only 85 households possessed cow or cattle. About half of the sample farmers hired implements for cultural operations. About 74 households owned television and 28 farmers owned video, 39 farmers possessed settle box, 27 farmers owned Radio, 122 farmers owned hand phone, 71 farmers possessed motor cycle, 12 farmers motor car, and cycle, some farmers owned bicycle receptively (Table 4 & 5). Luxury assets and farm assets were owned by different income groups of farmers. Where, high income farmers possessed the highest percentage of each asset. Medium income farmers used moderate amount of each assets and low income farmers owned the lowest percentage of most assets.

The farmers in the study area grew monsoon rice, summer rice and black gram. All of the sample farmers grew monsoon rice and average farm size was about 0.057 hec (5.7 acres), whereas 29 percent of farmers grew summer rice on the same acre of rice field. About 71 percent of farmer's possessed black gram owned about 0.015 hec (1.5 acres). Twenty percent of farmers grew vegetable and average farm size was 0.010 hec (1.0 acres) respectively. (Table 6)

The commonly used rice varieties were Manawthukha, and Lonethwehmwe. Most of the farmers used their owned seed stored from previous season. The seed rate used was 2 baskets for

monsoon rice and some farmer cultivated 1.25 baskets for summer rice while they were transplanted and broadcasted in monsoon rice. There was weeding practice in the survey area. Some Farmer used cow dung as bio-fertilizer which about 3 cart loads per acre in monsoon rice and about 2 cart loads in summer crops (Table 7)

Table 5 Farmer Assets Owned by Different Income Groups of Farmers in Percentage

Item	Housing Style			Luxury Assets							Farm Assets					
	Wood	Break	Bamboo	TV	Settle Box	Motor Car	Cycle	Bicycle	Three Weed	Hand Phone	Plowing	Hand	Threshing	Pump	Bullock cart	Cow/ Cattle
Low Income (N= 39)	10	1	28	15	0	1	22	25	0	34	9	1	1	1	11	28
Medium Income N=80	30	7	43	45	25	5	38	28	9	74	59	23	3	45	15	43
High Income (N= 15)	9	6	0	14	14	6	11	5	3	14	11	7	6	11	0	14
All Farmers (N=134)	49	14	71	74	39	12	71	58	12	122	79	31	10	57	26	85

Source: Field Survey 2019

Table 6 Percent of Households and Cultivated Area of Different Crops Grown by Farmers

Item	Household		Sown Acre		Mean Acres
	N	%	Minimum	Maximum	
Monsoon Rice	99	100	1	99.00	5.70
Summer Crop	29	29	1	28.00	3.69
Black Gram	71	71	0.6	70.6	1.50
Vegetable	22	20	1.2	18.8	1.00

Source: Field Survey-2019

Table 7 Input Used and Output of Selected Farmers (per acre) in Rice Production

Item	Monsoon Rice			Summer Crop		
	Amount	Price	Value	Amount	Price	Value
Input						
Seed (bsk)	2	9000	18000	1.25	8600	10750
Cow Dung (cart)	3	5000	15000	2	5000	10000
Weeding person)	7	3000	21000	5	3000	15000
Compound(kg)	50	10000	10000	50	10000	10000
Pesticide 1(liter)	0.53	3000	3000	0.53	3000	3000
Output						
Yield	80	5500	440,000	82	5000	410,000

Source: Field Survey, 2019

Most of the selected farmers applied urea-fertilizer or compound fertilizer at the rate of 50 kg per acre in monsoon rice while the rate is more than double in summer rice which was about

50kg per acre. The amount of pesticide applied in rice production was not so much in the study area. Yield of monsoon rice was about 80 baskets per acre and summer rice was yielded about 79 baskets per acre in the study area.

Analysis and Assessment of Cost and Benefit

In this research study, cost and return of monsoon rice, summer rice and black gram production were examined. Variable cost of production included material input cost and hired labour cost. Material input costs were calculated by multiplying unit amount and affective price or field price of inputs. Hired labour costs were valued by market wage rates and man days used in all farming practices. Return of rice production included return from sale with affective price or field price of rice. The data concerning with coast and return analysis of monsoon rice and summer crops production of selected farmers are presented in Table 3.9. It was found that total material cost of monsoon rice was 46,000 kyat per acre, 33,750 kyat per acre for summer rice and 85,000 kyat per acre for black gram.

Total labour cost of monsoon rice was 114,000 kyat per acre and that of summer rice and black gram are 104,000 kyat per acre and 50,000 kyat per acre. Total cost for monsoon rice production was 160,000 kyat per acre and that of summer rice and black gram were 137,750 kyat per acre and 135,000 kyat per acre.

Table 8 Input Cost and Return Cost of Rice Production (per acre), 2019

No	Items	Monsoon Rice	Summer Rice	Black gram
Cost				
Material Cost (MM Kyat)				
1	Seed	18,000	10,750	45,000
2	Cow Dung	15,000	10,000	10,000
3	Fertilizer	10,000	10,000	-
4	Pesticide	3,000	3,000	30,000
Total Material Cost		**46,000**	**33,750**	**85,000**
Labour Cost (MM Kyat)				
1	Preparation	-	-	-
2	Ploughing	5000	5000	5000
3	Harrowing	10,000	10,000	-
4	Replant	40,000	35,000	-
5	Irrigation	-	-	-
6	Weeding	3000	3000	-
7	Fertilizer	3000	3000	5000
8	Pesticide	3000	3000	5000
9	Harvesting/ Threshing/ Winnowing	50,000	45,000	35,000
Total Labour Cost		**114,000**	**104,000**	**50,000**
Total Cost		**160,000**	**137,750**	**135,000**
			Return	
	Yield Per Acre	80	82	15
	Price Per Basket	5500	5000	20,000
	Total Return	**440,000**	**410,000**	**300,000**
	Net Return	***280,000***	***272,250***	***165,000***
	Benefit cost ratio	***2.75***	***2.98***	***2.22***

Source: Field Survey, 2020

Based on the survey data, mean yields for monsoon rice were 80 baskets per acre, 82 baskets per acres for summer rice and 15 baskets per acres for black gram. Total return of monsoon rice was 440,000 kyat per acres and that of summer rice and black gram were 410,000 kyat per acre and 300,000 kyat per acre. Net return for monsoon rice was 280,000 kyat per acre and that of summer rice and black gram were 272,250 kyat per acre and 165,000 kyat per acre. Benefit cost ratio for monsoon was 2.75 and that for summer rice and black gram were 2.98 and 2.22. Net return of summer rice production was higher that of monsoon rice. So summer rice production and black gram production are more attractive for farmers (Table 8).

The Contribution of Summer Rice and Monsoon Rice Production to Share of Income and Expenditure Components

Mean total income for all farmers in the study area was 2095151 kyat per year. Of them all, farm income would be accounted for 1831382 kyat per year and 263769 kyat per year for non-farm income. Farm income contributed 87 percent of total income and non-farm income contributed 13 percent of total income (Table 9).

Among farm income, income from monsoon rice contributed 36% (about 659,917 kyat per year), income from summer rice contributed 57 percent (about 1,036,047 kyat per year) and income from other crops and farming involved only 7 percent (about 135,418 kyat per year).

Table 9 Income and Expenditure Shares of Selected Farmers

Items	Percent
Farm Income	95
Non-Farm	5
Total Income	**100**
Income from Monsoon Rice	44
Income from Summer Rice	41
Income from Others	15
Total Farm Income	**100**
Food Expenditure	59
Clothing Expenditure	5
Residence Expenditure	4
Education Expenditure	8
Other Expenditure	24
Total Expenditure	**100**

Source: Field Survey, 2019

Total expenditure of sample farmers in the study area was 1,102,311 kyat per year. Among which, food expenditure took the highest share which was 70 percent (about 733.83 kyat per year), 8 percent each for clothing and education expenditure. Residence expenditure included reparation of home, roofing and lighting. Residence expenditure contributed 4 percent of total expenditure. Other expenditure included 10 percent of total expenditure (about 122.827 kyat per year).

In Table 10 total household income of low income farmer was about 627,170 kyat per year, and total household expenditure was 638,833 kyat per year. In medium income, total household income was about 721,653 kyat per year, and total household expenditure was 1,102,311 kyat per year. Total household income of high income farmer was about 2,096,261 kyat per year but total expenditure of that farmer was about 1,078,884 kyat per year. Total household income of low

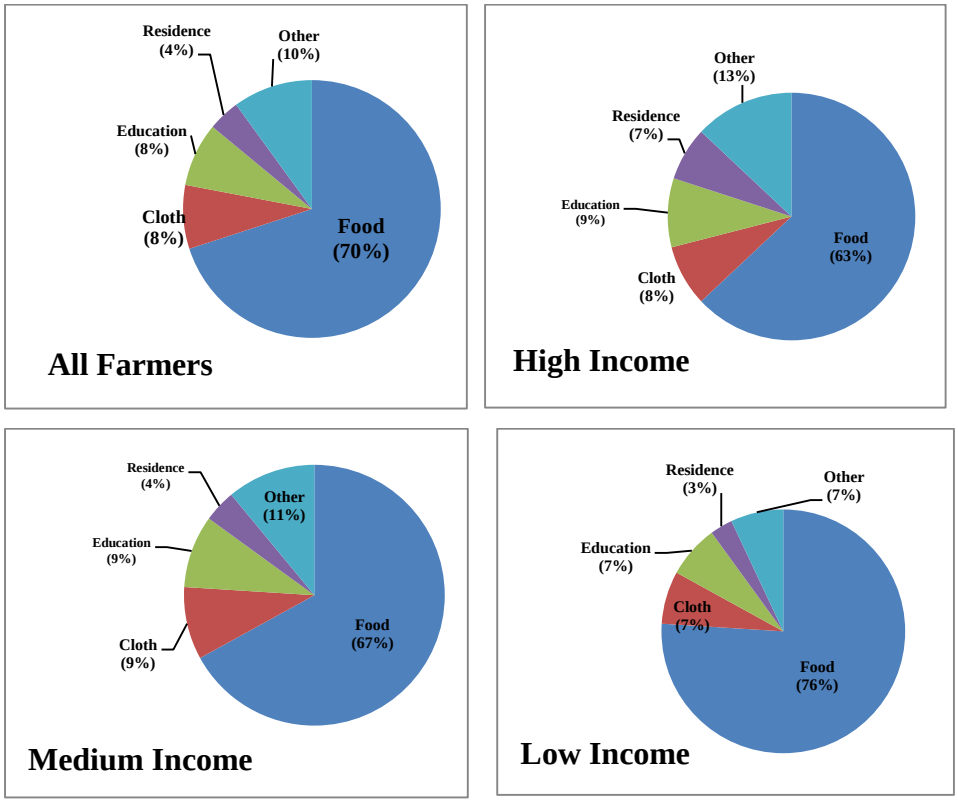
income farmer was lower than household expenditure of that farmer. It was evident that low income farmer faced with income shortages.

Table 10 Per Capita Income and Expenditure of Different Income Group of Farmers

Farmers With	Number	Per Capita Income (Kyat)			Per Expenditure (Kyat)		
		Per Year	Per Month	Per Day	Per Year	Per Month	Per Day
Low Income	29	600,000	50,000	1667	432,200	3,600	120
Medium Income	60	1,680,000	140,000	4667	199,800	16,650	555
High Income	11	3,600,000	300,000	10,000	304,200	25,350	845

Source: Field Survey, 2019

Per capita income of low income farmer was about 1667 kyat per day and per capita expenditure of that farmer was about 120 kyat per day. In medium income group of farmers, per capita income was 4667 kyat per day and per capita expenditure was 555 kyat per day. Per capita income of high income farmer was over 10,000 kyat per day and per capita expenditure of that farmer was 845 kyat per day. High income farmer can expend more expenditure, while income of low farmers just covers their expenditure.



Source: Field Survey, 2019

Figure 4 Share of Expenditure for All Income Groups of Farmers

Other expenditures included social, donation, recreation, and gambling. Clothing expenditure included umbrella, slipper, hat, light cloth, jacket etc. education expenditure included cost for registration, book, pencil, ruler, pocket money, tuition and others. Food expenditure share of high income group of farmer was 63 percent, that of medium income group of farmer was

67 percent and that of low income group of farmer was 76 percent. It can be clear that the lower the income they expend the higher expenditure percentage for food rather than other expenditures. Low income farmers could expend only 7 percent for social and other expenditure. (only half of high income group of farmers). Similarly, education and clothing expenditure for low income farmers (7 percent) were also than that of high (9 percent) and medium income farmers.

Conclusion

Myanmar's population is about 54.37 million people and two thirds of Myanmar people live in rural areas and are depends on agriculture and the food sector as their main source of livelihood. Increasing agricultural productivity, availability of rural employment, and sustainable rural livelihoods are keys to reducing poverty. Increasing agricultural and labour productivity will raise the incomes of the poor in rural areas.

This study emphasizes on estimating the household income, household expenditure, farmer assets and food poverty situation of the study area. Farmers are stratified into three groups, such as low-income farmers, medium-income farmers and high-income farmers to find out the incidences of poverty in different incomes groups.

The study is done for four villages (one village tract), Pauk Taw, Tat Poe, Ywa Ma, and Ze Phyu Kone Villages, based on the representative of the monsoon, summer rice and black gram growing farmers. A total of 182 respondents are interviewed in January 2020 for the growing season of 2019. The primary data such as social characteristics, cost of production, year per acre, total income and expenditure, etc. are collected from each respondent. Secondary data are mainly obtained from Land Records Department and the Ministry of Head Quarter Department.

Benefit-cost analysis is conducted to estimate benefit-cost (B/C ratios) for monsoon, summer rice and black gram production program. Benefit-cost (B/C ratios) for both rice productions is greater than one. Benefit-cost (B/C ratios) for summer rice production (2.98) was greater than that of monsoon rice (1.75), since summer rice production attained the higher benefit-cost ratio; it is more attractive for farmers.

Total income is used as the dependent variable and farm size, family size, permanent family labour; total expenditure and yield per acre are used as independent variables in analysis estimate. Farm size, total expenditure and yield per acre of rice are influenced on total income in this study. The rest of the variables are not significant and they have less effect on total income. In the result of calculation result or estimate, larger farm size earned more income than small farm size. Yield per acre of both monsoon and summer production highly influence on total income.

Yield per acre of rice production is a major source of income because if it is increased, income from the sale of rice will increase. Total expenditure highly relied on total income. If total income of farmers increases, the expenditure will increase. Therefore, the government should create more income source to increase the level of expenditure. Then, total income and total expenditure share are accounted. 87 percent of total income came from farm income and 13 percent came from non-farm income. About 57 percent of farm income could be accounted for summer rice production. 36 percent came from monsoon rice and 7 percent from other crops and farming. Income from summer rice took the highest share in farm income. So, it contributed the major income source in the study area.

On the other hand, the food expenditure is 70 percent and it took the highest share in total expenditure because it was essential for livelihood, expending 3 percent each for clothing and education, 9 percent on the residence and 10 percent for other expenditures such as social, donation,

and recreation and gambling. Food items contributed 75 percent and non-food items contributed 25 percent of the total expenditure. So, the food poverty situation of sample farmers is estimated.

The income needed for minimum per capita daily requirement of food is estimated as 302 kyats. The people whose per capita income below 302 kyats per day are referred to as food poor, total poverty line cannot be established because there is no standard used to measure non-food items. The headcount ratio for the study area is estimated as 38 percent, it is slightly lower to the estimate of 40 percent reported by FAO (1980-1990). It means 38 percent of total sample farmers' fall below food poverty threshold line. The headcount ratio of low-income farmers is 71 percent and of medium-income farmers is 29 percent. There is no incidence of poverty in high-income groups of farmers.

Limiting Factors

There is still a large gap between the farmers' yields and it indicates the various limiting factors affecting rice productivity and production range from farming techniques to marketing.

Suggestions

From the economic point of view, farmers benefited from rice cultivation have a relatively between farm size and family size. Crop diversification plays one of the major roles in the agriculture sector from the sustainable point of view. Samples of local farmers should be encouraged to use more fertilizer, family labour and machinery so as to increase productivity in rice cultivation. Good quality seed and hired labour should be used to offer for greater efficiencies and for increased cultivation in the study area. This could be done through provision of microfinance for rice farming of local farmers to enable the required inputs and hire labour for rice cultivation processes.

Planning and implementation of rice cultivation should be considered to increase the profitability and technical efficiency of rice production in the study area. Stakeholders should be provided the reducing production constrains associated with technical, socio-economic status and use of better quality seeds, control high transport and so on. After that, rice farmer associations should be formed to be better able to access market information and determinate this information to farmer groups and organizations providing greater transparency and access to local rice markets. The non-government, stakeholder and other agencies needs to continue to provide technical and financial support to farmer's organizations.

At the same time, assistance of administrators and policy makers should also provide the farmer's needs and to find out the solutions which are difficult to implement by the use of rice cultivation practices.

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PRELIMINARY SURVEY ON PESTICIDE USE IN CROP CULTIVATION AND IT'S IMPACT ON LOCAL FARMERS IN HINTHADA TOWNSHIP

Lè. Lè. Win[1], Moh Moh Khaing[2], Than Htike Aung[3], Khin Aye Mu[4]

Abstract

Hinthada Township is one of the townships located in deltaic area and large amount of rural people depend on agriculture especially paddy and black gram cultivation which is needed to use pesticide. Area of le land is 138382acres (56002.4 hectare) (73%of total cultivated land) and it supports paddy and black gram cultivation. Pests are one of the major problems in black gram cultivation and to get higher economic income from cultivation, pesticides are widely used. But, farmers' unsystematic pesticide use is dangerous on human health and environment. Local farmers do not know right information on pesticide uses and they suffer immediate illness and severe disease. Objectives of the paper are to present situation of agriculture of Hinthada Township, to explore pesticide use in agriculture of Hinthada Township, to examine the consequences of pesticide uses in Hinthada Township and to predict future prospect of pesticide uses in Hinthada Township. To present the paper, qualitative quantitative mixed method and GIS were applied.

Keywords: pesticides, unsystematic uses, human health and environment, immediate illness and severe disease

Introduction

Agriculture is one of the major economic activities and it support 70% of the population, and accounts for nearly 30% of national gross domestic product(GDP), 42% of GDP and it plays important role in poverty reduction (World Bank, 2019). Ayeyarwady Region is known as Myanmar's Granary due to fertile deltaic region. Double cropping area is large and paddy is mainly cultivated in the rainy season and black gram or summer paddy is cultivated in the cool dry period as double cropping. Because of double cropping, pests are common in pesticides are used in crop cultivation.

Pesticides were extensively used last many years ago.More than 18,000 pesticide products were licensed for use, and about 2 billion pounds of pesticides are used every year (Environmental Protection Agency 2002). Occupational exposure to pesticides caused incidence of nearly 20 cases of illness for every 100,000 workers in the US (Calvert et al. 2004). Mandour (2012) stated ground water is polluted with pesticides and Mahmoud et al., 2013 pointed that pesticide residues caused damage to livers and kidneys of animals used in agriculture.

In Hinthada Township, 81 percent of the farmers lived in the area practice paddy pulses system in which paddy is cultivated in the rainy season and black gram in cool dry period and the rest cultivate paddy only in which both monsoon paddy and summer paddy are cultivated (Myint Thida et al, 2018). Strategies for increased rice production include pesticide use and pesticides have been used widely in paddy cultivation (Huan et al. 2008). Pests are one of the major problems in Black gram cultivation and Lal and Sachan, 1987 said that 60 insect species are known to attack black gram crop at different stages of crop growth.

Aspelin (1997) said the global consumption of pesticides1 has reached 2.6 million metric tons. Although the largest volume of pesticide use is in developed countries, its use in developing

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countries increased (World Resources Institute (WRI), 1998). In Hinthada Township, Continuous and use of pesticides has resulted in harm to the environment, caused human ill-health, negatively impacted on production and reduced sustainability (Pimentel, 1997). Therefore, to present pesticide use in crop cultivation and it's impact on local farmers, Hinthada Township was selected.

Study Area

Among the 26 townships of Ayeyarwady Region, Hinthada included high population density in Ayeyarwady Region. Hinthada Township occupies the northern part of Ayeyarwady Region on the western bank of the Ayeyarwady River. Agriculture is major pillar of the economy of the area because of deltaic area. Like other agriculture region, local people living in the study area use pesticide widely to remove the pesticide for the purpose of getting high yield and greater economic return.

Objectives

Objectives of the paper are:

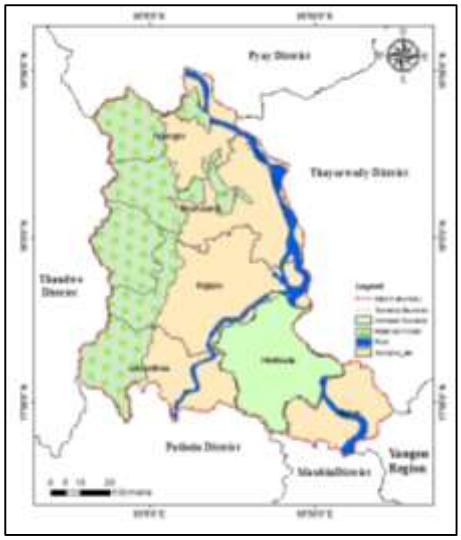
- To present the current situation of agriculture in Hinthada Township
- To explore pesticide use in agriculture of Hinthada Township
- To examine the consequences of pesticide uses in Hinthada Township
- To predict future prospect of pesticide uses in Hinthada Township

Data and Methodology

In primary data collection, 10 village tracts: Ywathit (north), Kawzan, Hpayargone, Kanhla, Chaungphar, Ywathargone, Tharsi, Ohnpinkwin, Natmaw, and Shwetaungytharya were selected as sample villages in which monsoon paddy, summer paddy and black gram are grown. 10 paddy- paddy farmers and 10 paddy-black gram farmers were selected from each village tract and 200 questionnaires were distributed to them.10 farmers were interviewed to get information on amount, application of pesticides, types and perception of farmers on health-related risk were collected through field observation, interviews and questionnaires. Literature review was thoroughly done. Secondary data were also applied and qualitative quantitative mixed method was applied in doing the research work and GIS tools were applied in drawing maps.

Background of Study Area

Hinthada Township is located in the northern portion of Ayeyarwady Region. It is situated between Ayeyarwady River and Ngawun River.



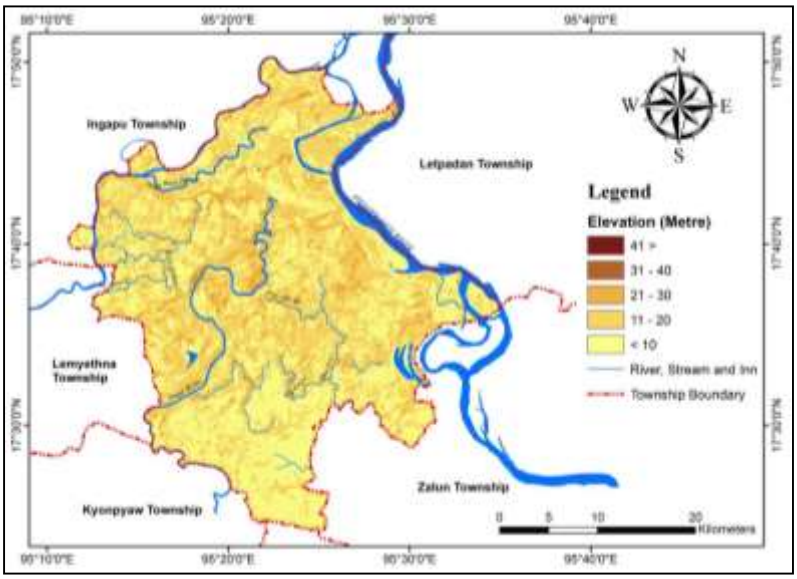
Source: MIMU

Figure 1 Hinthada Township of Ayeyarwady Region

Source: Agriculture Land Management Statistics

Figure 2 Hinthada Township of Ayeyarwady Region

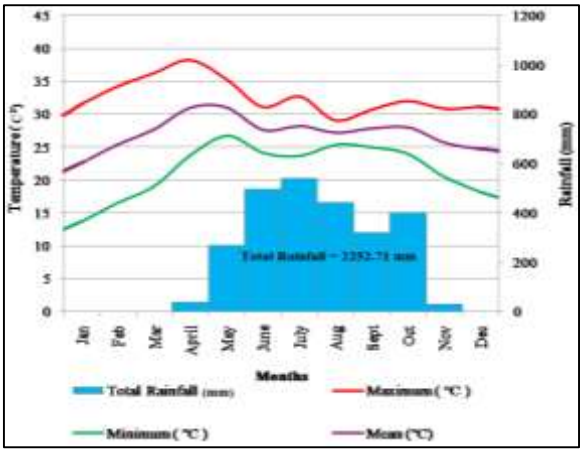
Hinthada Township is the second largest township in Hinthada District and its relief is characterized by low lying flat alluvial plain that is one of the supporting factors for paddy and pulses cultivation. The Ayeyarwady River is the most important river in this township, followed by Ngawun River. Other small streams are Natmaw and Daga and these rivers and stream support irrigated water for summer paddy cultivation.



Source: DEM

Figure 3 Reliefs and Drainage of Hinthada Township

April is the hottest month and January is the coldest month. April, maximum temperature is 38.25ºC and minimum temperature 13.75ºC in January, thus the range of temperature is 24.5ºC. The average total rainfall is 2252.71 mm.

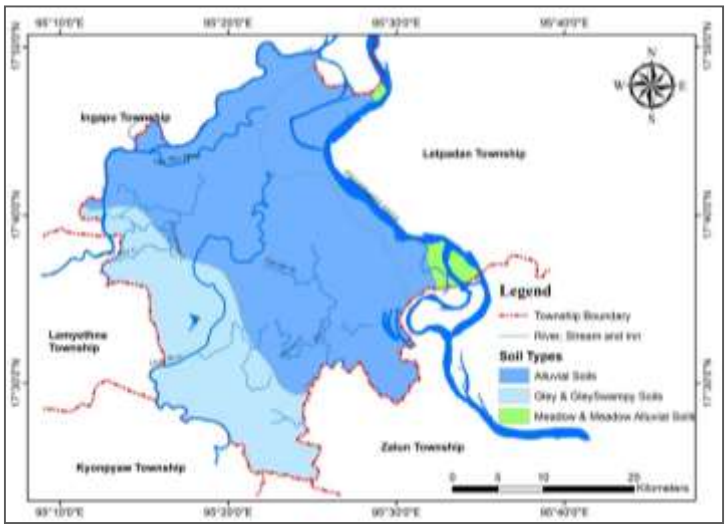


Source: Meteorology and Hydrology Department

Figure 4 Climograph of Hinthada Township (2010-2019)

Therefore Hinthada Township has Tropical Monsoon climate (Am) according to Koppen's system of climate classification.

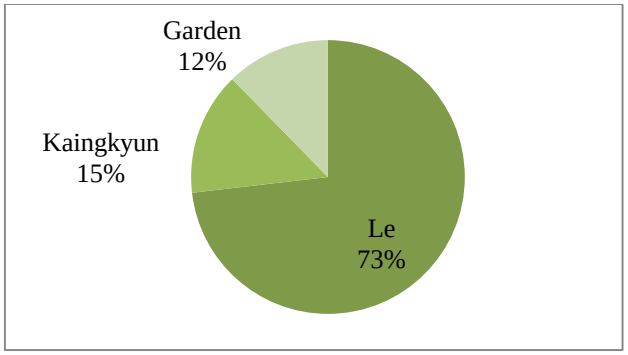
Three soil types: Alluvial Soils **(**Fluvisols), Gley and Gley Swampy Soils (Humic Gleysols), and Meadow and Meadow Alluvial Soils **(**Gleysols) are found in Hinthada Township. These soils are favourable for paddy and black gram cultivation.



Source: Meteorology and Hydrology Department

Figure 5 Soils of Hinthada Township

Population has been increasing and 72 % of the population lives in rural area. Rural population depends on paddy and black gram cultivation. Le land has an area of 138382acres (56002.4 hectare) (73%of total cultivated land) and it supports paddy and black gram cultivation.



Source: Department of Agriculture Land Management Statistics

Figure 6 Agricultural Land in Hinthada Township

Results and Findings

All rain fed paddy is medium and short lived varieties because farmers choose to cultivate them to reduce growing period to cultivate second crop after harvesting paddy. Monsoon paddy cultivated area was 54213 ha and productivity is 3.9 ton per ha. Productivity gradually increased in the study area and one of the reasons increase paddy productivity is pesticide uses. Pulses susceptible to pestilence and fungus infection and farmers, therefore, unavoidably use pesticides.

Although Myo Myint, 2014, stated that Pesticides uses are still small compared to countries like Vietnam, Thailand, China and India, Peeters et al, 2015, said that in Myanmar, Banned, unregistered pesticides are widely available and widespread overuse, misuse, mishandling and mismanagement of pesticides are too common. Therefore, Pesticides uses in cultivation become one of the major problems.

Pesticide uses

According to questionnaire survey, eighty two percent of farmers use the pesticide for the purpose of destroying of pests in paddy cultivation and black gram cultivation to increase the productivity. Eighteen percent of farmer does not use pesticide because of low investment and they are smaller holder farmers.

The local farmers use pesticides produced from Shwechinthae (Golden Lion), Myanmar Awbar, Wisara, Armo, Asiphate and Shwenaga (Gold Dragon) Company, Bing Hui Company etc.

Source: Author (28.6.2020)

Plate 1 Pesticide Spraying in Paddy Cultivation

Source: Author (28.6.2020)

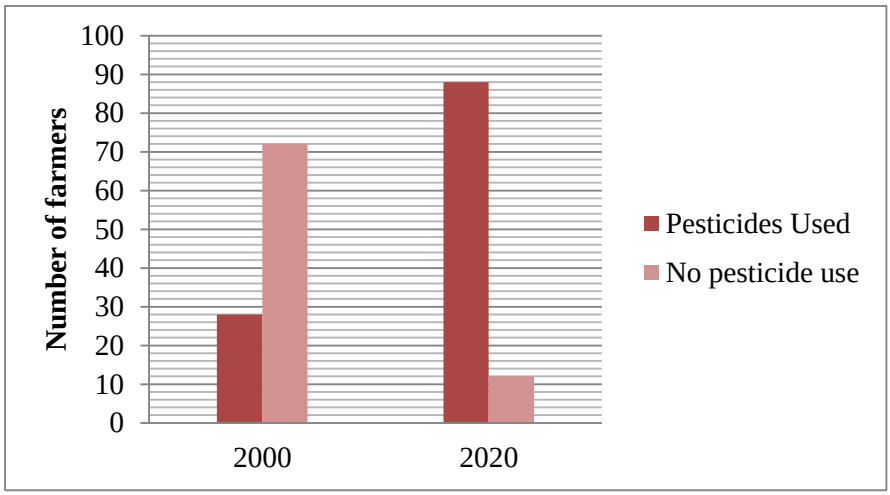
Plate 2 Pesticide Use in Paddy Cultivation

Source: Author (30.6.2020)

Plate 3 Pesticide used in Hinthada Township

According to interview with authorities, at present, pests are common and pest variety increased due to double cropping and climate changes. Therefore, farmers unavoidably use pesticide.

According to questionnaires' result, in 2000, 28 percent of the farmers used pesticides and pesticide used increased. In 2020, 88 percent of the farmers used pesticides. According to questionnaire results, small amount of pests were found in 2000 and a little pesticide were used in crops cultivation.



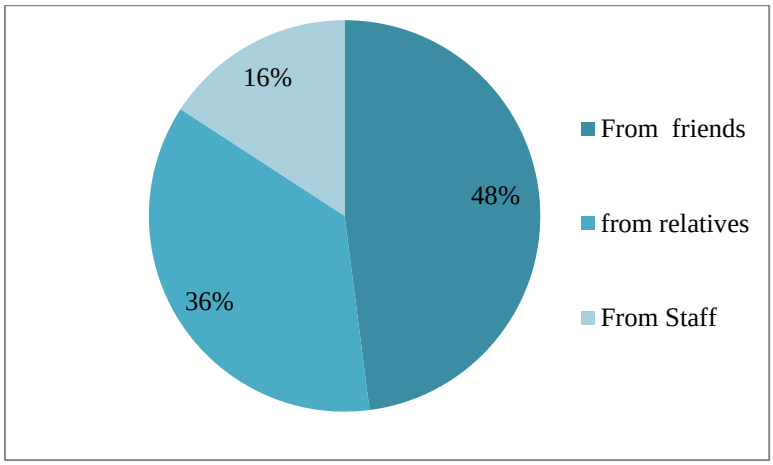
Source: Questionnaires' Results

Figure 7 Pesticide uses in Hinthada Township

In the study area, 28 percent of the monsoon paddy farmers use pesticide in monsoon paddy cultivation, 76 percent of summer paddy farmer and 87 percent in black gram farmer use pesticides.

According to interview, although pesticides are used in monsoon paddy, summer paddy and black gram cultivation, more pesticides are used in black gram cultivation because of high risks and high economic return.

Farmers in the area get information on pesticide uses from relatives, friends and staff of agriculture department. According to questionnaires' result, 36% (71 farmers) get information from relatives, 48% (94 farmers) from friends and 31% (16 farmers) from staff of agriculture department.



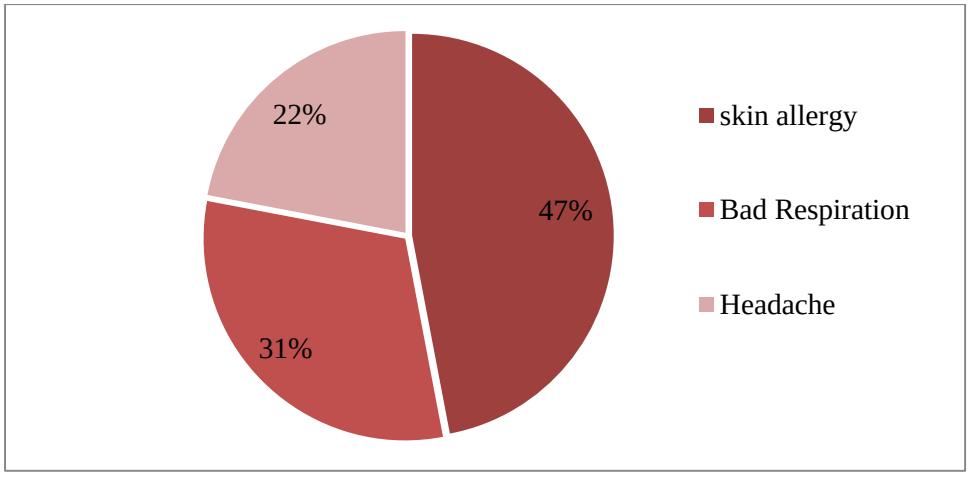
Source: Questionnaires' Results

Figure 8 Information Availability on Pesticide Uses in Hinthada Township

Pesticides are purchased from pesticide shops in Hinthada Town. Therefore, they use pesticide according to instruction of owners of pesticide shops. According to interviews with farmers, they read the instruction on the bottle and on the packs and practice according to this instruction.

In pesticide spraying, manual labours are still used in Hinthada Township. They are daily wage earners and they get 4000 ks per day or 5000 ks per day. They do not have much knowledge and the owners of the land led and give instruction. Therefore, they do not apply pesticide systematically and 36 percent (71 labours) use glove and masks but remaining pesticide sprayers do not use any glove and masks.

According to Ministry of Agriculture and Irrigation (2009), there are significant problems with low quality pesticides in the market. There are public health and environmental problems in Myanmar due to the adverse effects of pesticides.



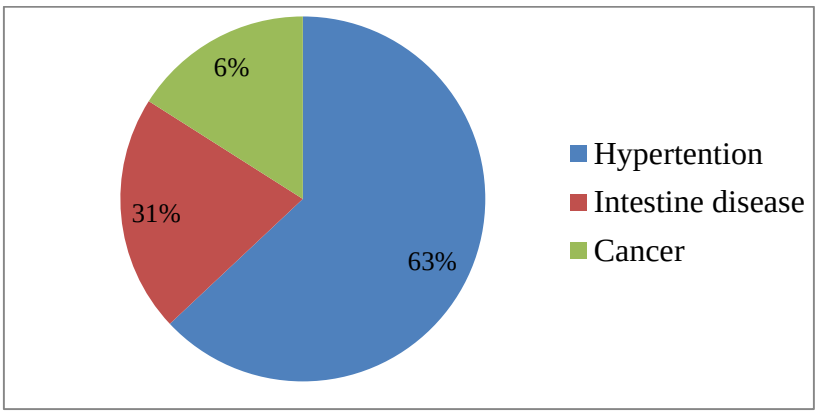
Source: Questionnaires' Results

Figure 9 Immediate illnesses on Pesticide Uses in Hinthada Township

Farmers do not exactly know the pesticide use and adverse effects of pesticides. But they know immediate effects of pesticide uses in cultivation. According to interview with sprayers, 47 percent of the sprayer suffer slight skin allergy, 31 percent bad respiration and 22 percent head ache.

Right information on pesticide uses is due to Lack of agriculture education. According to interview, they do not know that the threat of pest is highest in cool dry period due to double cropping.

Global New light of Myanmar, 2015, stated that Children are at greater risk of pesticide exposure than most adults. Pesticide uses affect human health such as nervous system, lung damage, reproductive dysfunction, and possibly dysfunction of hormone and immune systems, etc. According to questionnaires' result, 63 percent of the family household suffer hypertension, 31 percent intestine disease and 16 percent cancer.



Source: Questionnaires' Results

Figure 10 Human Diseases found in Hinthada Township

Chemical pesticides are unavoidably used in crop cultivation due to less awareness on pesticide and lack of agriculture education programmers. According to interviews, they do not know organic pesticide up till now.

There is no guarantee on pesticide use in Myanmar and it is dangerous for human as well as environment. According to interviews, growers use increasing dosages of pesticides or combine several chemicals to get more intense toxic mixtures. As a result, although even more pesticides were killed, resistance increased and human health and the environment are more affected by danger of pesticides.

Future Prospect

Myanmar's farmers is trying to get higher crop production by using pesticide in crop cultivation to get higher economic return and to meet the basic food need for increasing population. On the other hand, they do not have sufficient knowledge on agriculture education and environmental as well as health knowledge on pesticide uses.

Therefore, pesticides will be the major cause of environmental pollution that affects health of the local people. Farmers will suffer negative health impacts as Most farmers do not use protective clothing while they spray pesticides. According to interviews, traders sell pesticide containers of varying sizes, and that are restricted as they can seriously harm the health and the environment. It is dangerous for environment as well as human being.

Farmers in Hinthada Township are lack of awareness on environment and health, They dispose the used pesticide bottles and various size of containers, toxic are seeping into the ground and reach water bodies when it rains. This leads to extinction of fishes as well as other organism.

Therefore, in the future, problems caused by pesticide uses will be surely increased and the local people will encounter health problems concerning environmental pollution cause caused by pesticide uses.

Conclusion

The increase yield, higher yield and large economic benefit are usually short term. Pesticides' effects on local people' health and on the environment are long term and sometimes permanent. Even advantages of pesticide uses outweigh the disadvantages of applying agricultural pesticides at present, in the future disadvantages of pesticide uses outweigh its advantages. It is therefore needed to educate farmers, household members as well as authorities in the village on pesticide use. The role of the policy is critical for protecting environment and local people and it is needed to take actions on systematic pesticide use and disposing used pesticide bottles and tin. On the other hand, it is strictly needed to action for selling banned pesticide and unregistered pesticide. It is needed to support to farmers regarding best practices in sustainable pest management and pesticide use.

On the other hand, it is necessary to do further researches on environmental pollution, human health, soil deterioration, etc caused by pesticide uses in crop cultivation to be sustainable for new generations.

Acknowledgements

We would like to thank Dr. Kyi Kyi Mya, Professor and Head, Department of Geography and Dr. Khin Kay Khaing, Professor, Department of Geography Hinthada University for their permission to do the research paper and encouragement.We also thank to our friends for their helping hands.

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VEGETABLE MARKETING AND SUPPLY CHAIN OF HPA-AN TOWN

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Myint Myint Aye[4], Hnin Khaing Aye[5]

Abstract

Vegetables are major daily consuming item for human beings. Because of daily consuming item and cheaper price than meat, vegetable supply is important for people live not only in urban area but in rural area. In Hpa-an, although more than thirty types of vegetable are sold, eight major items are lime, tomato, corn, carrot, gourd, etc. Four vegetable markets are found in Hpa-an and vegetables come from various sources such as village tracts of Hpa-an Township, Thailand, Mawlamyine, Aungban, Tatkone, Thahtone, Yangon, Belin, Belukyun, etc. In supply chain, wholesale market, retail markets and customers are major links in vegetable supply chain of Hpa-an. Objectives of this paper are to examine types and sources of vegetables sold in markets in Hpa-an, to explore the flow of vegetables in Hpa-an, to investigate supply chain vegetables marketing in Hpa-an and to find out existing problems in vegetables marketing. Primary and secondary data derived from field survey, interviews, and secondary sources were analyzed and problems and issues related with vegetable market were presented.

Keywords: Vegetables, market, flow, supply chain, types of vegetable

Introduction

Vegetables are assumed as essential for well-balanced diets since they give vitamins, minerals, dietary fiber, and phytochemicals (Food and Nutrition Sciences, 2012). Most vegetables are noticeably low in fat and calories and vegetables give nutrients indispensable for health. Eating vegetables may decrease threat for heart disease, including heart attack and stroke (Nutrients and health benefits, 2014). Vegetable cultivation and production are one of the pillars on employment and income generation in the rural areas (World Development, 2007).

Vegetable farming is labor-intensive and its cultivation depends on high demands. Growing vegetables is a good practice in developing and rural areas (Ines Hajdu, 2015). A world vegetable survey showed that there are 392 vegetable items cultivated worldwide, representing 70 families and 225 genera (Kays and Dias, 1995). A growing number of urban consumers are also demanding safe vegetables (Figuié, 2004).

A supply chain is active process and includes the continuous flow of information, merchandise, and funds between different stages. The buyer is a fundamental part of the supply chain (Athalye, 2015). Worldwide the total volume traded in vegetables has increased fivefold from 1965 to 2005 (FAO, 2007). Vegetables are often highly perishable products and most of the vegetable are consumed in nearby areas. But, to meet the need for local demand, vegetables are used to import from nearby countries. Myanmar also imported vegetables from Indonesia, China, Thailand, etc.

In Hpa-an, vegetables are grown and also imported from Thailand through Myawaddy that is a very small border town engaging in transit trade and brokers trade vegetable through Myawaddy (Yu Yu Naing, 2012).

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Vegetable wholesaling and retailing are found in markets of Hpa-an. Hpa-an was selected to present vegetables markets playing wholesaling, retailing, and supporting for local people from geographical point of view.

Objectives

- To examine types and sources of vegetables sold at the markets in Hpa-an
- To explore the flow of vegetables to Hpa-an
- To investigate the supply chain vegetables marketing in Hpa-an
- To find out existing problems in vegetables marketing

Data and methodology

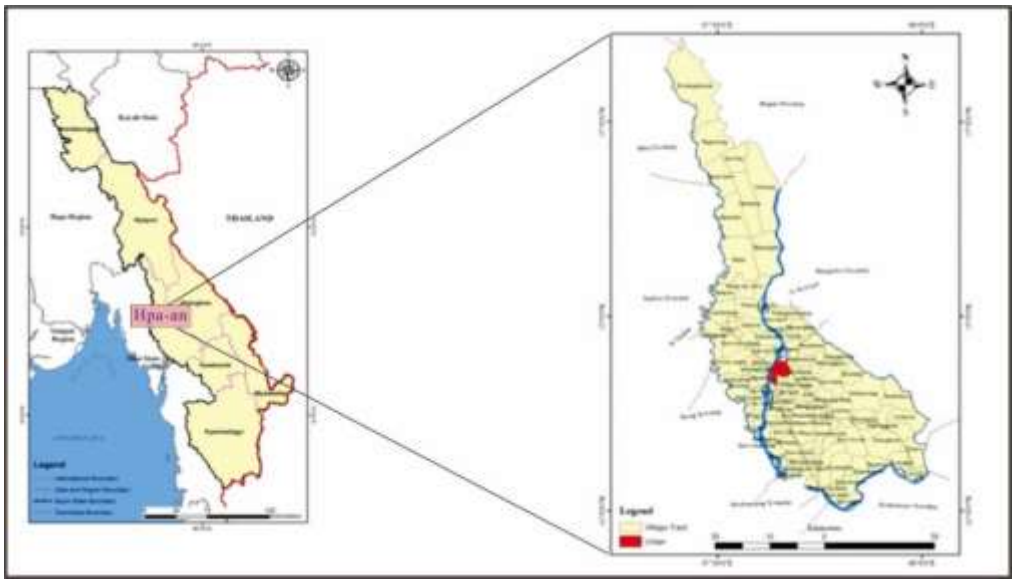
To present vegetables markets of Hpa-an, exploratory approach was used. Four wholesalers, four retailers and ten customers were interviewed and questionnaires were distributed to fifteen wholesalers, fifteen retailers and thirty customers. Survey period was from January, 2020 to July, 2020.

The survey is mainly done to collect primary data on types and sources of vegetables, buying, selling, the demand, price, vegetable flow in the vegetable market. Focus group discussion has also been carried out with the shop owners, users and local people of the vegetable market. To assess the current status of vegetable markets of Hpa-an, it is needed to outline the underlying logistical supply chain routes of vegetables. Therefore, supply chain of vegetables was presented.

All the primary and secondary data from field survey, interviews, Township Development Committee, and secondary sources were analyzed and problems and issues related with vegetable market were presented.

Geographical Background of Hpa-an

Hpa-an is located between the North latitudes 16° 30' 15" and 17° 42' 30" and between the East longitudes 97° 22' 30" to 98° 0' 10". It has an area of 2901.02 square kilometers (716857 acres).



Source: MIMU

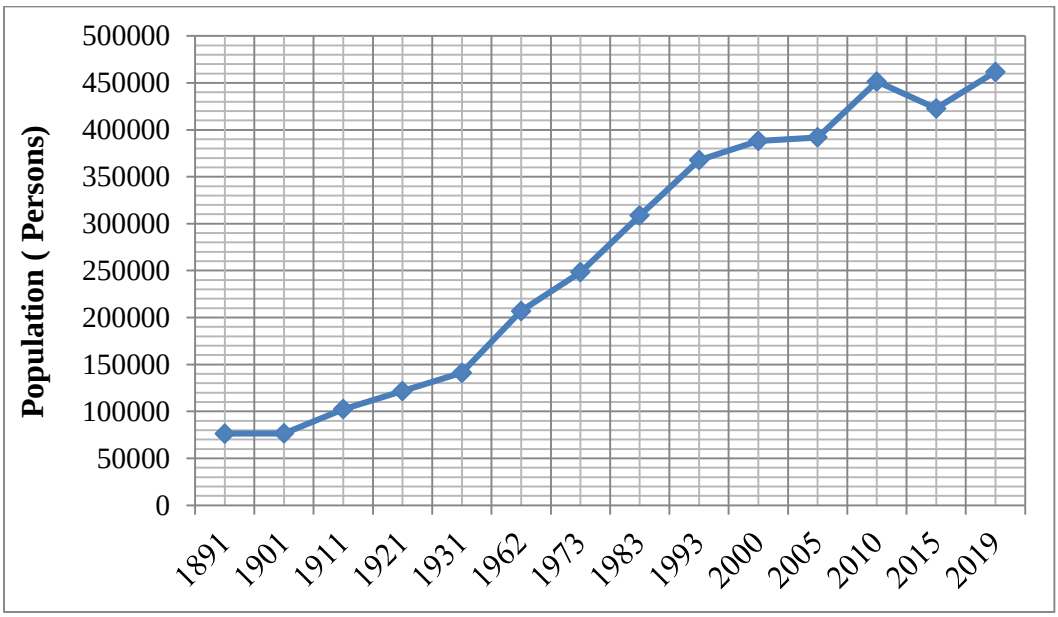
Figure 1 Hpa-an Township (left) and Hpa-an (right) in Kayin State.

In Hpa-an Township, northern part is higher than southern part. The area with an elevation below 25 metres (82 feet) covers more than 60 percent of the Township's area. The low land area supports annual crop cultivation including vegetable cultivation. Vegetables are also grown on Kaing-kyun land in Hpa-an.

Mean temperature of Hpa-an is 27.72°C and the coldest month is December with mean temperature of 26.11°C. The hottest month was May with mean temperature of 29.85°C. The average annual rainfall of Hpa-an, was 2396.31 millimeter (94.34 inches). According to the Koppen's classification, Hpa-an Township experiences Tropical Monsoon type of climate (Am). Vegetables are grown not only in the rainy season but also in cool dry period.

Soils of the township are Meadow Alluvial Soils (Fluvisols), Brown Meadow Soils (Gleysols), Meadow Gley Soils (Gleysols) and Red Brown Forest Soils (*Rhodic Ferralsol*). Vegetables are grown on where the soils are unsuitable for vegetable cultivation by means of land preparation.

In 1973, total population was 248362 persons and it increased to 461606 in 2019. Like other area, population and demand for vegetable also increases. People living in Hpa-an are major customers of vegetable markets. In 2019, urban population was 62842 persons (14percent) and the rural population 398764 persons (86 percent). Not only rural population but also people living in urban area cultivate vegetables.



Source: Labour, Immigration and Population Department, Hpa-an

Figure 2 Population Growth of Hpa-an Township

Results and Findings

Vegetable Markets in Hpa-an

Four vegetable markets are found in Hpa-an, Yaebaw Market (No-1, Sanpya Market) in Ward No-2, Yebaw Market (Mann Aung Market) in Ward No-5, Maebaung Market (No-2, Sanpya Market) in Maebaung Village and Thiri Market in Ward No-6. Yaebaw Market is a major market that is a wholesale as well as retail market in Hpa-an.

Source: General Administrative Department

Figure 3 Vegetable Markets of Hpa-an

In Hpa-an, most vegetable growers sell their vegetables to brokers who come and collect vegetables from the villages and then, fetch to the Yaebaw Market at which broker and transporter, wholesalers, retailers, and customers meet for the purpose of supplying vegetable in Hpa-an and other towns such as Mawlamyine. Therefore, Yaebaw Market is a major place for vegetable marketing.

Retailers from Yebaw, Maebaung and Thiri markets buy vegetables from Yaebaw Market with wholesale price and they again sell in other small markets with retail price. Most vegetables flow to Maebaung Market and remaining three markets play vegetable retailing only and they mainly serve the people of nearby areas.

Source: Author (22.6.2020)

Plate 1 Yaebaw Market (No-1, Sanpya Market)

Source: Author (27.6.2020)

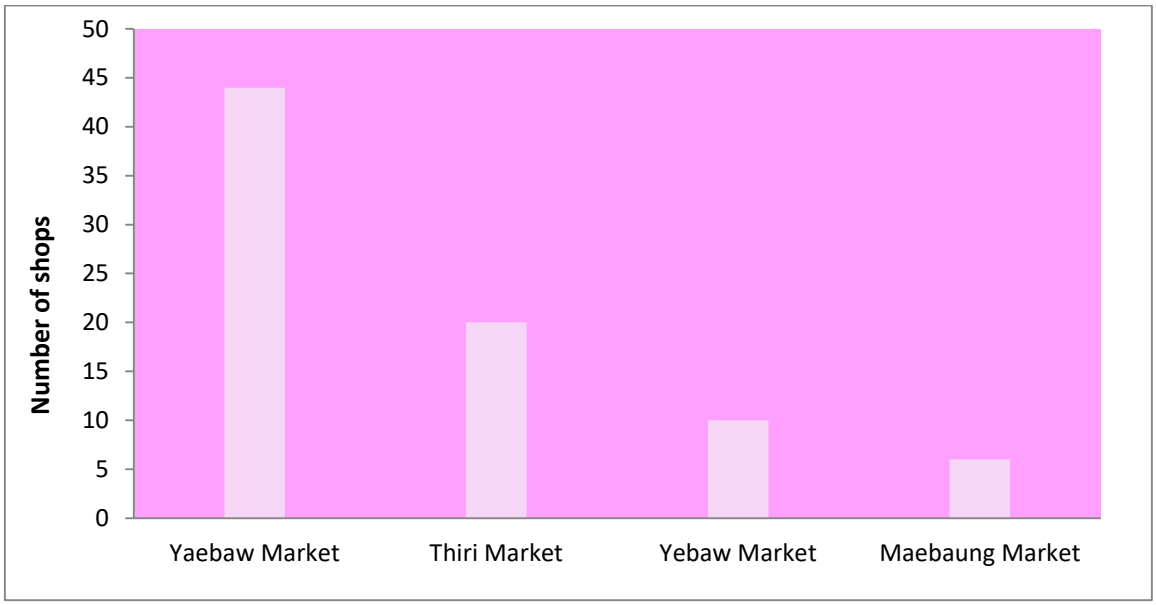
Plate 2 Maebaung Market (No-2, Sanpya Market)

Source: Author (22.6.2020)
Plate 3 Vegetable shops in Yaebaw Market

Source: Author (27.6.2020)
Plate 4 Vegetable shops in Maebaung Market

Moreover, Hpa-an has a Farmers' market but it was omitted as it is not a regular market and it was found once per month.

The number of shops is largest in Yaebaw Market (No-1, Sanpya Market) due to large wholesale market and better accessibility and smallest in Maebaoung Market (No-2, Sanpya Market) located fringe area of Hpa-an.



Source: Market Development Committee

Figure 4 Number of Vegetable shops in Hpa-an

Types of vegetables

Hajdu, 2015, grouped vegetables in to five types: leaf vegetables (lettuce, cabbage), fruit vegetables (pepper, cucumber, and tomato), root vegetables (carrot, radish, and sweet potato), bulb vegetables (garlic, onion) and flower vegetables (cauliflower, broccoli). But, to present the paper, vegetables are grouped into three types: leaf vegetables, fruit vegetables and root and bulb vegetables.

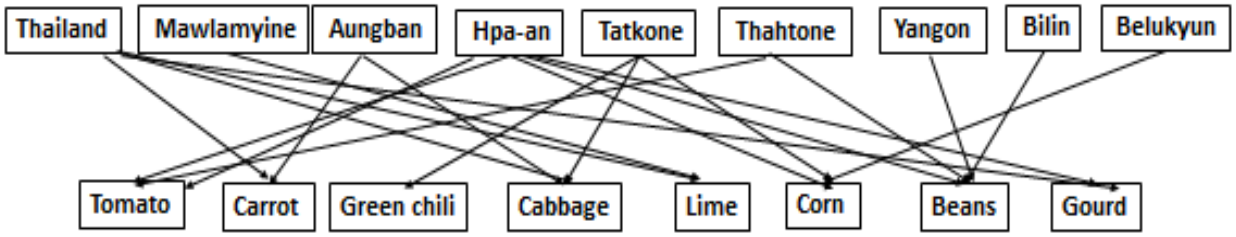
In Hpa-an, major vegetable items sold in the markets are fruit vegetables such as bottle gourd, pumpkin, cucumber, eggplant, lime, tomato, okra, drumstick, etc., leafy vegetables such as roselle, mustard, lettuce, cabbage, Chinese cabbages, acacia pennata, bell pepper etc. and root and bulb vegetables radish, carrot, young bamboo shoot, sweet potato and potato.

Sources and flow of Vegetables

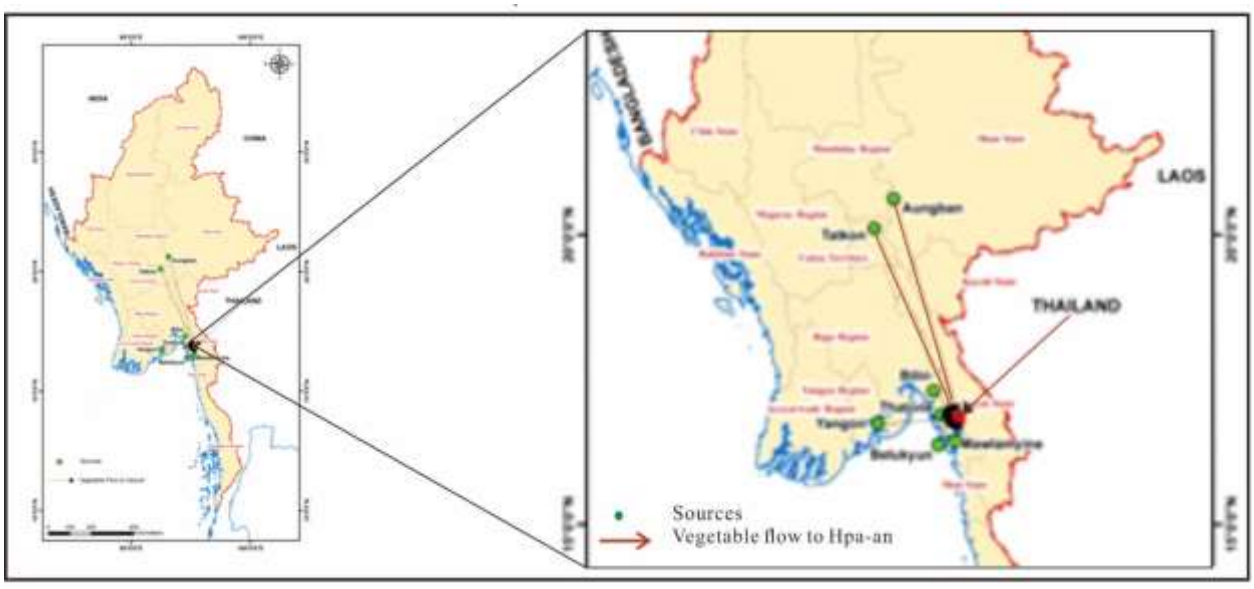
In Hpa-an, vegetables are mainly grown on Kaing-kyun land and most vegetables are produced there. Moreover, small number of vegetables are also grown in le land and in residential compound. In the study area, cabbage, cauliflower, lettuce, gourd, tomato and coriander are grown in the winter season and water crests, roselle, radish, string beans, ground, lady finger, egg-plant, pumpkin and cucumber are cultivated in the rainy season.

Although more than thirty items of vegetable are sold in vegetable markets in Hpa-an, most common nine items: tomato, carrot, green chili, cabbage, lime, corn, beans and gourd were selected to present sources and flow of vegetables.

Vegetable market in Hpa-an come from various sources, village tracts of Hpa-an Township, Thailand, Mawlamyine, Aungban, Tatkone, Thahtone, Yangon, Belin, Belukyun, etc.



Flow Chart: Flow of Vegetables



Source Market Development Committee

Figure 5 Vegetable Flow of Hpa-an

Most vegetables are carried from Thailand through Myawaddy and amount of vegetable fetch from Thailand is second largest in amount of vegetable sold in Hpa-an. Vegetables fetched by pickup cars from Thailand are less fresh than those produced in Hpa-an due to time spend on the way. Most vegetables especially leafy vegetables are not suitable for long-term storage. But, transporting vegetables with refrigeration is not found in the area.

Although Myawaddy and Hpa-an take only three hours, vegetables may have been plucked a day before sending to Hpa-an. But these vegetables are better physical appearance and large in size. Therefore, vegetable fetched from Thailand are best selling items because of customers' preference. Nearness to Thailand is locational advantageous for Hpa-an vegetables market. Although Aungban located in Shan State is far from Hpa-an, carrot and cabbage are brought from there.

Hpa-an produces many vegetable items and vegetables produced from Hpa-an are more fresh and cheaper due to low transport cost. But, some vegetables such as carrot, sweet potatoes, green chili, etc. produced in Myanmar cannot compete to those produced in Thailand due to better appearance.

Seasonal changes in vegetable supply pattern

According to interviews with vegetable sellers, seasonal changes in vegetable supply pattern are found in the area. In the rainy season, cabbage, cauliflowers, rosella, watercress, lime, lettuce, and young bamboo shoots are major supplied items and horseshoes, coriander, ridge gourd and radish are less supplied items due to highly perishable, less durable, and high risks in cultivation. Major supplied items in winter are green chili, drumstick, maize, cabbage, cauliflowers and eggplant, sweet potato, etc. and less supplied items are snake beans, tomato, broccoli, and cucumber.

Vegetables marketing Calendar

Months	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Major items in the rainy season							Cabbage, cauliflowers, rosella, lime, lettuce, and young bamboo shoot					
Major items in Winter	Green chili, drumstick, maize, cabbage, cauliflowers, eggplant, tomato and sweet potato										Green chili, drumstick, maize, cabbage, cauliflowers, eggplant, tomato and sweet potato	

Rainy Winter

Source: Open talks and Interviews with vegetable sellers

Supply Chain of Vegetables

In studying supply chain of the vegetable markets, growers, brokers, sellers of wholesale market, seller of retail markets and customers are included. But, on the other hand, from wholesale vegetable market of Hpa-an, vegetables are fetched to other nearby towns especially Mawlamyine. To present supply chain of the vegetable, sellers of wholesale market, seller of retail markets and customers were stressed because they directly play important role in supply chain of the vegetables in Hpa-an.

Source: Open talks and Interviews with vegetable sellers

Flowchart: Vegetables supply chain in Hpa-an

Wholesalers

Brokers send vegetable produced from other area in Myanmar and Thailand to Hpa-an. Traders from other area as well as Hpa-an use high way cars, private cars or motorbikes for their trading operations to send vegetable to wholesale market. But some use hired transport vehicles because their cash are mainly used in investment for buying much amount of vegetables. Wholesalers are intermediaries and they are major link between brokers and retailers. Wholesalers need more investment for buying many vegetable items.

Wholesale market sells the vegetable from 6 a.m. to 5 p.m. Retailers from three markets buy vegetable at Yaebaw Market. From wholesale market of Hpa-an, vegetables such as young bamboo shoot, eggplant, etc. are carried to Mawlamyine. When vegetables imported from Thailand are sold, trimming of leafy vegetables is not needed to be carried out because of systematic packaging. Vegetables collected from other areas within Myanmar are needed to be cleaned and repackaged again. Wholesalers' first priority is physical appearance of the vegetables for the purpose of selling high price.

According to interviews, the vegetable items that give high profit for sellers are beans, cabbage, watercress and roselle, but, low profit are coriander, carrot, tomato, mustard, etc. Due to fragile and perishable items in wholesale market. Wholesalers encounter the loss when heavy rain, flooding, etc. happen after collecting vegetables from brokers. But it rarely occurs, and it is found once per two or three years.

According to questionnaires' answers, 72 percent of the wholesalers buy vegetables in cash down system and remaining 28 percent practice the. system of buying on credit payable at the next purchase.

Retailers

Vegetable retailing has been considered as a very low-margin business (Sengupta, 2008). Retailers use much smaller amount of investment than wholesalers. The cost of vegetable including transport cost is high when the marketplace is far from the farmland. As a consequence, the amount collected and sold by the retailers is small and as economic benefit.

Retailers are intermediaries between wholesalers and customers. In general, all the retailers are inevitably dependent on the local wholesales market selling various vegetable items with wholesale price. Price change in wholesale market affects the supply and demand of trail market.

According to interviews with retailer, vegetables from Thailand are more expensive due to transport cost but they give high benefit due to high market demand caused by better physical appearance. The vegetables that cause losses are coriander, whit lettuce, bell chili, etc. due to high perishability. The vegetables that give high profit are rosella, water cress, tomato produced in Hpa-an due to cheaper price, common use, preferences and, carrot, sweet potato imported from Thailand due to better physical appearance.

Customers

Customers play the last part of the supply chain because of end point. In Myanmar, research works stated that consumer preference based on cleanness, size, ripeness, and form, etc. (The MIMU, 2015). Although consumers' preferences differ from one person to another depending on sex, age, socioeconomic status and other factors, some criteria are the same among consumers (Udomkun et al, 2018). According to interviews, appearance and freshness of vegetables are vital factors affecting customer's choice and plays important role in vegetables marketing, particularly leafy ones.

At present, people become aware on food safety issues due to a number of food-related incidents and reported outbreaks worldwide. The World Health Organization (WHO) has reported up to 30% of the people of developed countries suffer from foodborne diseases since 1985. But, the rate in developing countries is unidentified. Vegetable safety includes conditions and actions that are necessary during cultivation and preparation (Badrie, 2016). Langiano et al., 2012, said that over 30 to 40% of foodborne illness cases result from the home and is still progressively increasing.

According to questionnaires' result, 72 percent of the respondents aware the pesticides used in vegetable cultivation affect human health in Hpa-an. But they do not know foodborne diseases caused by unsystematic vegetable cultivation. According to interviews, the knowledge on pesticides-used vegetable cultivation is available from friends, radio, and relatives. Although they would like to pay less in vegetable buying, their main priority is freshness.

Conclusion

Hpa-an has four vegetable markets in which one wholesale and retail market and three retail markets are included. Fruit vegetables such as bottle gourd, pumpkin, cucumber, eggplant, etc. and leaf vegetables such as roselle, mustard, lettuce, cabbage, etc. are mainly sold. Vegetables are mainly come from Hpa-an, Thailand, Mawlamyine, Aungban, Tatkone, Thahtone, Yangon, Belin, Belukyun, etc. Vegetables from Thailand are brought through Myawaddy that is a very small border town engaging in transit trade including vegetable trade. Vegetables are carried by highway cars, private cars, and motorcycles.

Vegetables produced in Hpa-an cannot compete that produced in Thailand due to lack of knowledge on poor growing methods, packaging, and physical appearance. Farmers use chemical fertilizers and pesticide in vegetable cultivation to get an appealing appearance. Wholesalers and retailers know that effects of chemical input use in cultivation, they lack practice and action on systematic vegetable cleaning.

Supply chain of the vegetable includes growers, brokers, sellers of wholesale market, seller of retail markets and customers in which latter three are mainly found in vegetable market of Hpa-an. Supply chain of the vegetable shows links between wholesalers, retailers and customers. Wholesalers get higher benefit than retailers due to higher investments.

In Hpa-an, like other areas, people become aware health and longevity and relation between food and health. It is needed to plan sufficient safe vegetable availability for local people. Moreover, it is necessary to educate people on organic or natural vegetables consumption that is low risk on health. It is needed to pay more attention to effects of pesticide in vegetable consumption and to educate health risks. Further researches on vegetables marketing such as quality and price of the vegetable, consumer preferences, perception of consumers on vegetable consumption and health, etc. should be done in the future to be safe vegetable supply for the people live in the area.

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DRAINAGE BASIN MORPHOMETRIC ANALYSIS IN BAGO RIVER BASIN USING GEOSPATIAL TECHNIQUES

Saw Thandar[1], Khin San Yu [2]

Abstract

Drainage basin morphometric information is very important to manage the incidence of flooding in an area. The main aim of the research is to assess the basin morphometry of Bago River Basin and evaluate its hydrological implication as relating to flooding. In this research, the topographic maps and satellite imageries are used to analyse for the hydrological and geographical techniques for basin delineation, stream ordering and digital elevation modelling. All of the results showed that the drainage basin is characterized by stream segments, mean bifurcation ratio and stream frequency. The flood potential area of the Bago River Basin assessed by the morphometric analysis,

Keywords: *Basin; dendritic; drainage; flood; morphometry.*

Introduction

The drainage basin is a unique geographical unit characterized by distinct drainage network and ecosystem (Samson et al., 2016). A drainage basin morphometry study involves linear and relief parameters of the basin which help us to understand the natural environment of the basin and also they summarize spatial characteristics of the basin. Morphometry is the measurement and mathematical analysis of the configuration of the earth's surface, shape and dimension of its landforms (Jahan, C.S., Rahaman, M.F., Arefin, R. et al., 2018). In recent time, these methods are used to analyse in several ecological hazards directly or indirectly associated with drainage morphometry include flooding, erosion, mass movement, soil pollution and deforestation etc. Bago River Basin morphometric is provided to understand the underlying factors controlling the hydrological behaviour as well as providing the mandatory data and consequent implication of hydro-related disasters.

Study Area

The Bago River basin covers an area of approximately 5358 sq.km and is located between North Latitudes 17º 10" and 18º 05" North Latitudes and between 96º 00" and 96º 50" East Longitudes (Figure 1). In the study area, the northwestern part is higher than the south and southeastern part, at an elevation ranging from 6m to about 800 m above sea level. Bago City is also located in the study basin area.The Bago River basin is significantly affected by the lithological characteristics and faulting and jointing. According to the geology time scale, this study area has mainly found Holocene-Recent Alluvium, Miocene-Upper Pegu Group and marine, brackish and terrestrial equivalents. Miocene-Pliocene - Irrawaddy Group and equivalents. And also, Meadow Alluvium soil, Yellow Brown Forest soils are mostly found in this area.

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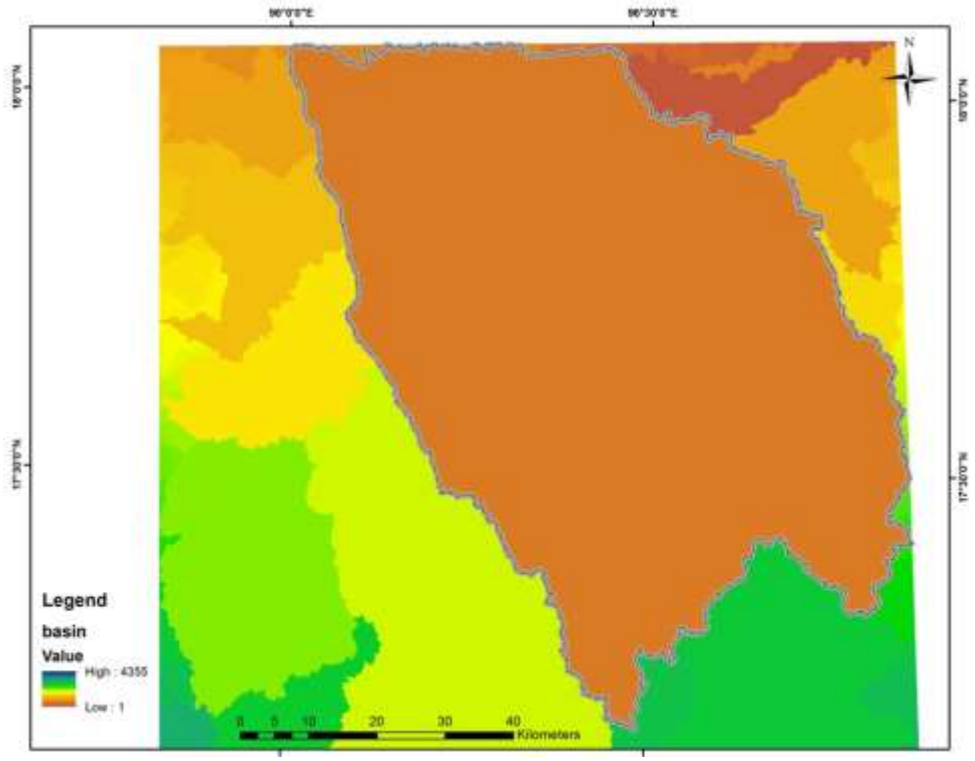


Source: created by ASTER DEM(30 m)

Figure 1 The Study area of Bago River Basin

Aim

- To assess the basin morphometry of Bago River Basin and evaluate its hydrological implication as relating to flooding.

Objectives

- To identify the drainage morphometric characteristics of the Bago River basin and
- To examine the implication of the morphometric characteristics on basin flood potential in the study area.

Methods and Data Used

Morphometric analysis for Bago River Basin was conducted using topographic maps with a scale 1:50,000 (10 m contour interval), ASTER DEM, and Arc GIS 10.4.1 software package. ASTER DEM is used at present to delineate watershed and sub-watershed boundaries, and drainage networks, to derive and calculate drainage morphometric parameters of the Bago River Basin. Different terrain features or maps for the study area such as aspect, slope, and elevation were generated using the Spatial Analyst tool. Topo sheets were used initially to demarcate the boundaries of the watersheds, then, the Arc Hydro tool was utilized to delineate the final watershed boundaries and stream networks of the Bago River Basin.

The stream order maps created from the flow direction map for each watershed using Stream Order tool. The stream ordering system was based on a Strahler's method. Basic morphometric parameters like area (A), basin length (L_b), perimeter (P), stream order (u), stream number (Nu), stream length (Lu), were measured directly from the DEM using GIS software. Other parameters are also included bifurcation ratio (Rb), drainage density (Dd), drainage frequency (Fs), length of overland flow (Lo), circularity ratio (Rc), elongation ratio (Re), basin relief (Bh), relief

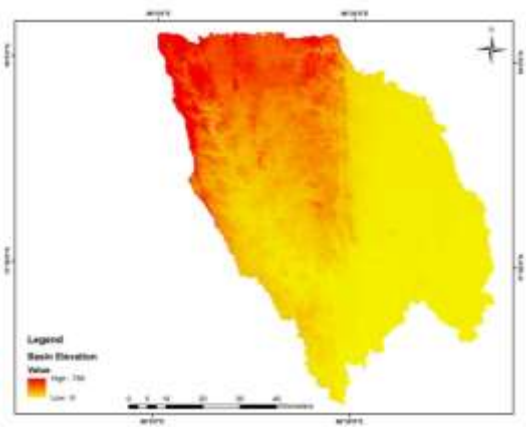
ratio (Rr), form factor (Rf), and shape factor (Bs) were calculated from mathematical equations illustrated in Table 1.

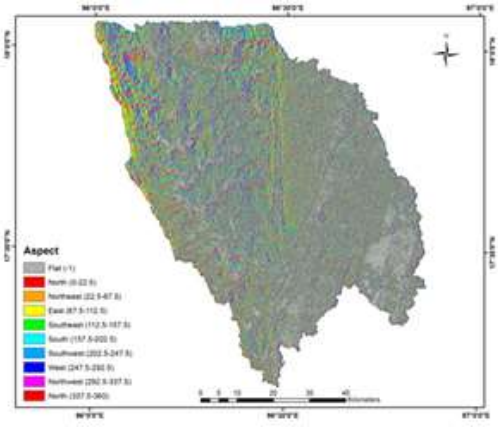
To assess floods potential for Bago River Basin, according to the Strahler (1958), the simple morphometric method which has been designated to estimate flood risk levels and the degree of hazardousness for the basin. Two different approaches were elaborated to determine the hazardous area. Among these approaches, the first is based on the relationship between bifurcation ratio (R_b) and drainage density (D_d) and the second is employed the relationship between bifurcation ratio (Rb) and stream frequency (Fs). Drainage density (D_d) refers to relief dissection, runoff potential, and infiltration capacity of surface materials, climate, and land cover of the watershed. Low values of D_d indicate the most favourable conditions of infiltration, thus decreasing runoff potential, while, high stream frequency (Fs) characterises impermeable sub-surface materials, poor vegetation cover, high relief, and low infiltration capacity, thus, increasing runoff potential. The resultant illustrations for D_d vs. R_b and Fs vs. R_b have to be plotted graphically, where each illustration contains two curves dividing the flood potential area. And also create Land cover and land use map using Landsat image.

Results and Discussion

Morphometric Analysis

Quantitative analysis of the Bago River Basin was based on 19 morphometric variables which represent drainage network, geometry, texture, relief ,aspects and land use of the basin area (figure 2 to 6). The drainage pattern of the Bago River Basin is dendritic to sub-dendritic type on dip slopes. In the present study, stream ordering for the Bago River Basin has been ranked according to the Strahler's method of the hierarchical ranking system. The calculated morphometric parameters are illustrated in Table 1.

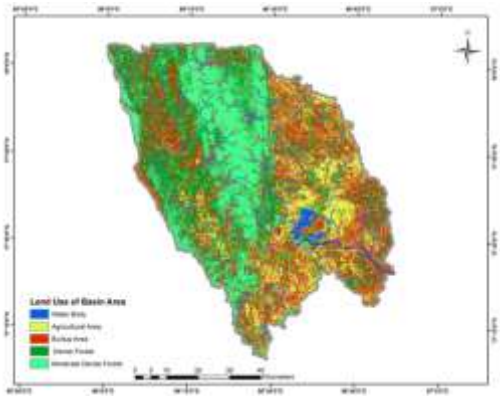




Source: created by Aster DEM (30 m)

Figure 2. Elevation of Bago River Basin

Figure 3. The Aspect of Bago River Basin



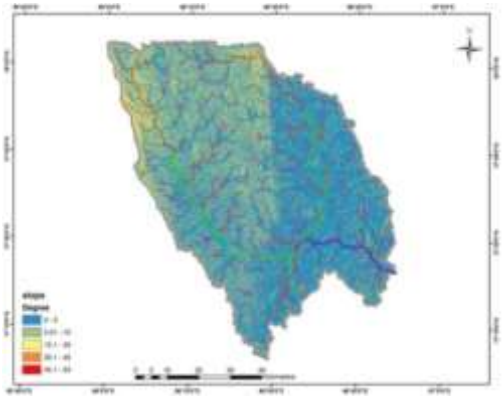


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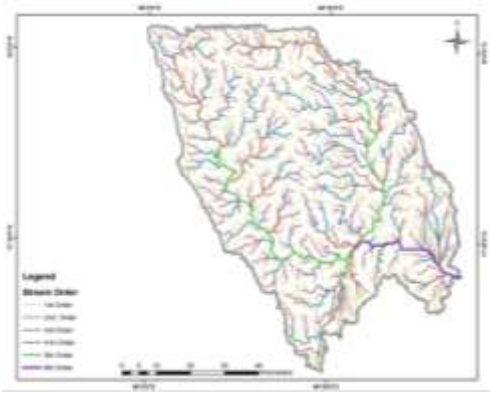
Figure 4 The Land Cover / Landuse map **Figure 5** The Slope map



Source: created by Aster DEM (30 m)

Figure 6 The Stream order map of Bago River Basin

Table 1 Morphometric parameters and their formula.

Morphometric parameters	**Formula/definition**
I. Drainage network	
1) Stream order (u)	Hierarchical rank
2) No. of streams (N_u)	$N = N_1 + N_2 + \cdots + N_n$
3) Stream length (L_u) km	$L_u = L_1 + L_2 + \cdots + L_n$ (km)
4) Mean stream length (L_{sm}) km	$L_{sm} = L_u/N_u$ (km)
5) Stream length ratio (R_L)	$R_L = L_u/L_{u-1}$, where Lu = the total stream length of order"u", L_{u-1} = the total stream length of its next lower order
6) Bifurcation ratio (R_b)	$R_b = Nu/Nu+1$, where Nu = total no. of stream segments of order"u", Nu+1 = no. of segments of the next higher order
7) Mean bifurcation ratio (R_{bm})	R_{bm} = average of bifurcation ratio of Strahler all orders
II. Basin geometry	
8) Basin length (L_b) km	Length of the basin (km)
9) Basin area (A) km^2	Plan area of the watershed (km2)
10) Basin perimeter (P) km	Perimeter of the watershed (km)
11) Form factor (ratio) (Rf)	$Rf=A/L_b^2$
12) Elongation ratio (Re)	$R_e = 1.128 \sqrt{A}/L_b$
13) Shape factor (B_s)	$B_s = L_b^2/A$
14) Lemniscate ratio (k)	K = L2/4A
15) Circularity ratio (Rc)	$Rc = 4*\pi*A/P2$
16) Drainage texture (Dt)	Dt = N_u/P, where Nu = Total no. Streams of all orders, P = perimeter (km)
III. Drainage texture analysis	
17) Stream frequency (Fs)	Fs = Nu/A
18) Drainage density (Dd)km/km^2	Dd = Lu/A
19) Drainage intensity (Di)	Di = Fs/Dd
20) Length of overland flow (L_o) km	L_o = 1/2 Dd
IV. Relief characteristics	
21) Basin relief (B^h) or total relief (H) m	Bh = h − h1, where, h = maximum height (m), h1 = minimum height (m)
22) Relief ratio (R_r)	Rr = H/Lb, Where H = total relief, Lb = basin length
23) Ruggedness number (R_n)	Rn = Dd*(Bh/1000)
24) Dissection index (Dis)	Dis = Bh/Ra, where Ra = absolute relief
25) Hypsometric curve (HC)	HC is achieved by plotting the proportion of the total height (h/H) against the proportion of the total area (a/A) of the basin, where H is the total relief height, a is the total area of the basin above a given line of elevation h.
26) Hypsometric integral (Hi)	Hi = (H−H) (H−h) , where H = the weighted mean elevation, H = maximum elevation, h = minimum elevation

Source: Adapted from Strahler (1958)

Table 2 Morphometric Characteristics of Bago River Basin

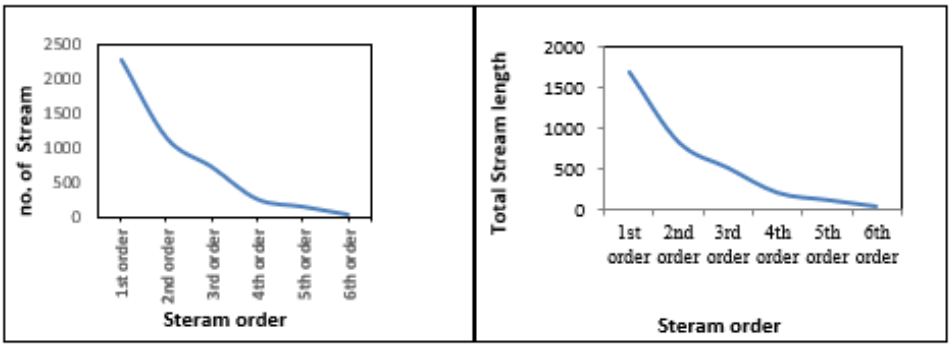
Sr.No	Streams	1st order	2nd order	3rd order	4th order	5th order	6th order
1	Total length(km)	2255.26	1137.33	721.76	262.09	155.51	42.82
2	Total no. of Stream	1691.00	825.00	508.00	202.00	113.00	33.00
3	Mean(Lsm)	1.33	1.38	1.42	1.30	1.38	1.30
4	Bifurcation Ratio ($R_{b)}$	2.05	1.62	2.51	1.79	3.42	
5	length Ratio(R_L)		0.50	0.63	0.36	0.59	0.28
6	Basin Length	116.02					
7	Basin Area	5357.65					
8	Basin Perimeter	502.13					
9	Drainage Density	0.85					
10	Basin Relief	753.00					
11	Relief Ratio	0.17					
12	Elongation Ratio	1.22					
13	Basin Shape	2.51					
14	Circular ratio	0.27					
15	Stream frequency (Fs)	0.63					
16	Form factor (Rf)	0.40					
17	Drainage texture (Dt)	6.72					
18	Drainage intensity (DI)	0.74					
19	Length of overland flow (Lo) Km	0.43					

Source: Adapted from Strahler (1958)

The calculated morphometric parameters are illustrated in Table 1 and this basin area is of sixth-order basin. The structure, lithology, morphology and slope steepness are mainly influencing on the drainage network development. By contrast, lithological uniformity and relative availability of rainfall and long dip slopes intensified erosional processes, thus stream length and area increased at a rate exceeding the rate of increase in stream number.

Drainage Network

The total number of streams (Nu) for the Bago River Basin is 3372, and among these stream order, the first order streams account for 50.15% of the total number of streams in basin. The details of stream characteristics are ascertained by Horton's first law (Horton, R. (1945), the "law of stream number", which states that the number of streams of various orders in a given drainage basin tends to closely approximate an inverse geometric ratio. This inverse geometric relationship is shown graphically in the form of a straight line when no. of the stream is plotted on an ordinary graph (Figure 7). It is also verified that the number of streams gradually decreases because the stream order increases. 1) Stream length (Lu) is a major effect of hydrological property and indicative of runoff characteristics, geomorphic development of stream segments, and tectonic instability. Generally, the higher the order, the longer the length of stream are in nature. The steam length has been calculated according to the law elaborated by (Horton, R. (1945).



Source: Horton's First law and second Law

Figure 7 Relationship between no. of Stream, Stream Length and Stream order

The total stream length is 4574.77 km of the basin. The first order streams constitute 50.15 % of the total stream length related to in the Bago River Basin. The stream length characteristics of the Bago River Basin verifies Horton's second law, the "law of stream length", which indicates that the average length of streams of each of the various orders in a drainage basin tends to closely approximate a direct geometric ratio. The geometric linear relationship is shown graphically when the log values of these parameters are plotted on a normal graph (Figure 7). However, slight deviations from a straight line are obvious at high and low orders due to uplifting of the Bago River Basin. 2) Mean stream length (Lsm) values of the stream order for the basin are nearly identical. Stream length ratio (RL) is that the ratio between the mean length of streams of a given order to the mean length of streams within the next lower order. RL is taken into account a significant factor about both drainage composition and geometric development of drainage basins. A significant variation occurs in RL values between the streams of different orders pertaining in Basin (0.5 – 0.28). This variation is attributed to morphological changes in slope and relief along the basin and also the youth-age stage of geomorphic development of the watersheds as verified later through hypsometric analysis (Table 2). 4) Bifurcation ratio (Rb) is elaborated by Horton as an index of relief and dissection. Its value is approximately 2 for flat or rolling drainage basins, and up to 3 or 4 for mountainous or highly dissected drainage basins. Characteristically, Rb values range between 1.62 and 4.42 for watersheds during which the geological structures distort the drainage pattern. In contrast, lower values of Rb are representative for structurally less disturbed catchments without any distortion in drainage pattern (Schumm, S.A. (1956). Abnormally high bifurcation ratio exposed the regions of steeply dipping rock strata. The result of the mean bifurcation ratio (Rbm) for the basin is 2.28, therefore, this basin is an almost flat area. The drainage development of the basin is remarkably influenced by structural disturbances such as faulting, uplifting of the Bago River Basin and rejuvenation of the drainage network.

Basin Geometry

A significant variation exists in the values of morphometric parameters which represent basins geometry like basin area, basin length and basin perimeter. The area of the Bago River Basin is 5357.65 km^2. Basin length of the study area is also 116.0191km (Table 2). Moreover, the perimeter of the basin is 502.13 km. Form factor (R_f) is expressed as the ratio between the area of the catchment (A) and the square of the catchment length (Horton, R. (1945)). The Rf parameter is examined to predict the intensity of a basin of a defined area. For a perfectly circular basin, the value of the form factor should always be less than 0.79 (Chopra, R., Dhiman, D. and Sharma, K. (2005)). The smaller the value of Rf (<0.45), the more the basin will be elongated. Catchments with high Rf have peak flows of shorter duration, whereas elongated watersheds with low form

factors have lower peak flow of longer duration (Youssef, A., Pradhan, B. and Hassan, A. (2011)). The Rf value of the basin is 0.4 that is indicating elongated shape and suggesting a flat hydrograph peak for a longer duration. Flood flows of such elongated basins are easier to manage than watersheds developed towards rectangular to a circular shape. Thus, high peak flows of shorter duration are expected during flash floods. Therefore, the morphological characteristics of a basin have powerful impacts on watershed hydrology. Elongation ratio (Re) is defined as the ratio between the diameters of the circle of the area as represented by the drainage basin to the maximum basin length (Schumm, S.A. 1956). Strahler, A.N. (1964) stated that Re values vary generally between 0.6 to 1.0 over a wide range of climate and geological conditions. Values close to 1.0 are characteristic of regions with very low relief, whereas values in the range of 0.6 - 0.8 are normally diagnostic of watersheds with high relief and steep slopes. Where Re approaches 1.0, the shape of the drainage basin approaches a circle (Schumm, S.A., 1956). It has been concluded that a circular basin is more efficient in the runoff than is an elongated one (Singh, S. and Singh, M.C. 1997). Re value for Bago River Basin is greater than 1 (Table 2) that indicate are approaching the circular shape. Shape factor (Bs) is calculated by dividing the square of the length of a basin by the area of the basin (Horton, R., 1945) and is considered in inverse proportion to the form factor (Rf). The shape of the drainage basin along with the length and relief affect the rate of water and sediment yield. Bs values for the basin are 2.51, therefore, it may have a longer basin lag time.

Circularity ratio (Rc) refers to the ratio of catchment area (A) to the area of circle having the same circumference as the perimeter of the catchment (Miller, V.C., 1953). The Rc is controlled by the length and frequency of the streams, geological structures, landuse, land cover, climate, relief and slope steepness of the catchment. Drainage basins with a range of circularity ratios of 0.4 to 0.5 were described by Miller, indicating that they are strongly elongated, highly permeable, with homogeneous geological materials. The Rc for the basin is 0.27 indicating that is characterized by high relief, elongated and relatively permeable surface resulting in greater basin lag times, while catchments belonging to the dip slopes show delayed time to peak flow. It can be concluded that Rf, Re and Rc significantly influence the hydrological response of the Bago River Basin. Also, the combination with basin shape and the arrangement of stream segments has a direct influence on the size and shape of flood peak (Ward, R.C. and Robinson, M., 2000).

Drainage texture (D_t) denotes relative spacing of drainage lines in a fluvial dissected terrain. It is defined as the total number of stream segments of all orders per perimeter of the drainage basin (Horton, R., 1945). Drainage texture (D_t) is also one of the main concepts in drainage basin geomorphology. D_t is dominated by several intrinsic physical factors such as climate, rainfall, vegetation, soils, lithology, infiltration-capacity, relief and stage of basin development. Smith, K.G (1950) has identified five different texture categories: drainage density < 2 indicates very coarse texture, between 2 and 4 is described as coarse texture, between 4 and 6 is moderate, between 6 and 8 is fine, and >8 is very fine drainage texture. The D_t values for the Bago River Basin are 6.72 exhibits fine drainage texture.

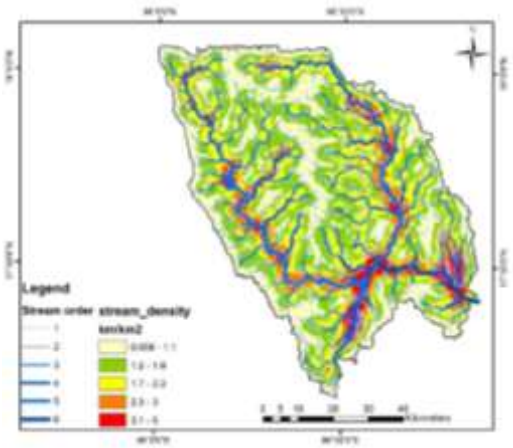
Drainage Texture Parameters

Stream frequency (Fs) acts as the ratio of the total number of streams (Nu) in a basin to the basin area (A) and is defined as the number of streams per unit area (Horton, 1945). Fs values are mainly depended on the lithology of the catchment and reflect the texture of the drainage network. The Fs values are positively correlated with D_d value of a watershed, which means that the increase in stream population is connected to that of drainage density (Tucker, G.E. and Bras, R.L., 1998). High stream frequency means more percolation concerning to drainage density and thus more groundwater potential (Sreedevi, P.D., Sreekanth, P.D., Khan, H.H and Ahmad, S., 2013). The observed stream frequency (Fs) value is 0.63 in the Bago River Basin. The Fs values indicate steep

slopes, with low permeability rocks, thus facilitating less infiltration and greater surface flow and high flooding potential area.

Drainage density (D_d) is examined the closeness of spacing of channels and regarded a quantitative expression of terrain dissection and runoff potential of the catchment. Drainage density is a measurement of the total lengths of streams in a catchment per unit area. High drainage density of an area illustrates high runoff, consequently low infiltration rate, whereas; low drainage density of an area also illustrates high runoff, and consequently low drainage density of an area refers to low runoff and high infiltration. Other significant parameters determining of the D_d are infiltration-capacity of the soils, and initial resistances of terrain to erosion well-drained basins have a drainage density of 0.85, in the study area.

Length of overland flow (L_O) associates with the length of water over the ground before it becomes concentrated into definite steam channels. It is considered the most important independent variable affecting hydrological and geomorphological development of drainage basins. According to Horton, (1945) the average length of overland flow is relatively half the average distance between stream channels, and thus, is approximately equal to half of the drainage density. Length of overland flow relates inversely to the average channel slope (Patel, D., Dholakia, M., Naresh, N. and Srivastava, P., 2012). The Lo value for the basin area is 0.43 indicating very steep slopes and shorter flow part.



Source: calculated from variables

Figure 8 Stream Density in Bago River Basin

Relief Characteristics

Basin relief (Bh) or "total relief" of a watershed is defined as the difference in elevation between the highest and lowest points on the basin (Schumm, S.A., 1956). Commonly, relief measures are indicative of the potential energy of a drainage system present by the elevation above a given datum (Strahler, A.N., 1964). Basin relief is a significant factor in understanding the denudational properties of the catchment, landforms and drainage networks evolution, overland flow, through flow, and erosional behaviour of the terrain. The total relief of the study area is 753m. Relief ratio (Rr) is analysed to measure the overall steepness of a drainage basin.

Conclusion

The 19 variables of the Bago River Basin is calculated for morphometric analysis. A significant variation exists in the geomorphometric parameters characterizing both categories. Drainage density (D_d), relief ratio (Rr), elongation ratio (Re), circularity ration (R_c) and ruggedness number (R_n) vary significantly. High values of mean bifurcation ratio (R_{bm}) designate the structural and lithological control on drainage network development across the study area. The variation in stream length ratio points out the variation in morphological characteristics of the watersheds especially slope and topography. A dendritic drainage pattern dominated in the study area. Bago City is located in the flat area and the stream density is also high. Due to the conditions, this area always experience under flooding every year. This study analysed the socioeconomic of the flood vulnerable areas are endangered, and recommends preparedness for potential flood hazards in the area. Therefore, most of the variables are important for the basin morphology and flooded area.

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ANALYSIS ON THE CLIMATE OF LASHIO TOWNSHIP: THE CASE OF RAINFALL FLUCTUATION AND ITS TREND

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Abstract

The climate of Lashio is classified as irregular because of large inter-yearly variations in the climatic elements, especially the amount of rainfall. According to Koppen's climatic classification system, the climate of Lashio is Cwa climate (Humid Subtropical Climate) depending on the amount of average temperature and total rainfall. Annual variability in rainfall is markedly significant and monthly rainfall also varies from year to year. This paper explores annual and monthly of rainfall in Lashio over the period between 1980 and 2019. This study has displayed the existence of trends in annual and monthly rainfall, however in which months are decreasing trends and in which months are increasing trends. Decline in rainfall in the months might have serious agricultural implications because most agricultural activities in this area rely on rainfall of this period. The declining in the annual rainfall may lead to the lowering of the water table. This study will be of assistance to better inform farmers as well as agricultural decision makers, also study of temporal fluctuation and trends of rainfall may be used to characterize the climate of the area.

Key points: climate, temperature, rainfall, fluctuation, and trend

Introduction

Climate is perhaps the most important component of the environmental system. It influences man in diverse ways. Man, in turn influences climate through his various activities. The influence of climate on man and his activities may be benevolent or malevolent. Human health, energy and comfort are affected more by climate than by any other element of the natural environment whereas the activities of man in certain locations and over a period of time may lead to increasing maladjustment of man to his climatic environment. In the study of climate for a given area, it is essential to analyse how the climatic controls effect upon the climatic elements (i.e. temperature, precipitation, air pressure and wind) and variation patterns of these elements and types of climate. Thus, rainfall is one of the key climatic variables that affect both the spatial and temporal patterns of water availability. Water has become a prime concern for any development and planning including food production. So, rainfall is very crucial for the economic development of Lashio Township as the integral percentage of the people get involved in rain fed agriculture (crop and plantation). The distribution pattern of rainfall in Lashio Township is most uneven and varies considerably from year to year. In order to have a reliable estimate of rainfall fluctuation, it is necessary to analyze the recent and expected future trend of annual and seasonal total rainfall. Knowing the variations in the general rainfall pattern is valid to understand rainfall variations. Thus there is the need to study the short term structure of rainfall characteristics especially in the study area being a fairly new state (40 years) with recent development affecting rainfall and being affected by rainfall. Keeping above points in mind the study is carried out for Lashio Township, Northern Shan State.

Study Area

The study area covers the Lasiho Township. Lashio Township is located in the Northern Shan State lies on the Mandalay-Muse motor road. It is located between latitude 22° 35' 53" N and 23° 4' 27" N and between longitude 97° 31' 10" E and 98° 22' 48" E. The area of Lashio Township is 2,628.63 square kilometers. Rugged, mountainous and moderately to steeply sloping area nearly

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the whole region and narrow alluvial plain on the central lowland area and western lowland area and southern lowland area generally characterize the topography of the township. Comprising some parts of the alluvial plain is a flat tract of land. However, the majority of the places are an undulating and rolling topography. The location of the outer north side cordillera with N-S stretching is on the northern edge of the township with elevation of about 2,169.7 metres.

Objectives

The main aim of this study is to analysis the rainfall trends and variability over Lashio. In order to achieve main aim, the following specific objectives were conducted;

- to study the general climatic condition of Lashio
- to determine monthly and annual rainfall variability
- to analyze the temporal pattern of rainfall for modals
- to investigate statistical and graphical rainfall trends

Data and Methodology

The required data and information to examine the climate of Lashio and its rainfall variability and trend were collected from the Department of Meteorology and Hydrology (DMH), Lashio Township, Shan State and the Department of Geography, Lashio University. To present quantitatively the variation pattern of climatic elements in Lashio, the techniques of descriptive statistics (i.e. Average, Standard Deviation, and Coefficient of Variation) are applied.

Analysis and Discussion

The General Climatic Condition of Lashio

Lashio is situated on the northern part of the Eastern Shan Plateau. As Lashio lies in the Humid Subtropical Climate Zone of Myanmar, most of the land surface has elevations over 762 smetres above sea level; and although there are no big forests, Lashio generally has a Humid Subtropical Climate due to geographical location. The yearly average mean temperature is 22.04° C. In examining the conditions of temperature during the 40-year period from 1980 to 2019, it is found that the yearly average maximum temperature is 29.86° C; the yearly average minimum temperature is 14.22° F and the yearly average mean of temperature is 22.04° C. In studying the temperature conditions during the year, January is the coldest month with the average mean temperature of 15.22° C, the average maximum temperature and average minimum temperature of January is 26.22° C and the 4.23° C respectively. The hottest month is April with the average mean temperature of 23.80° C, the average maximum temperature and average minimum temperature of April is 33.66° C and the 13.93° C respectively. See Table (1). According to the data of rainfall records obtained from the Meteorological and Hydrology Department of Lashio Station, during the 40-year period from 1980 to 2019, the yearly average rainfall of Lashio is 107.34 mm. Within a year the average number of rainy days is 184 days. The conditions of the relative humidity of Lashio differ from one season to another. Even during a day, the relative humidity of the morning session is not the same as the evening session. In observing the conditions of the relative humidity of Lashio during the period 1980-2019, September is the highest relative humidity and April has the least relative humidity. Wind and atmospheric pressure are related weather phenomena. Winds blow from high to low pressure systems. The average hourly wind speed in Lashio experiences mild seasonal variation over the course of the year. The windier part of the year is from December to May. The windiest month of the year is March with an average hourly wind speed of 2.9 miles per hour. In Lashio, the average percentage of the sky covered by clouds experiences extremes

seasonal variation over the course of the year. The clear part of the year in Lashio begins around ending October and lasts ending around April. On February, the clearest day of the year, the sky is clear. The cloudier part of the year begins around April and lasts ending October. On July, the cloudiest day of the year, nearly the sky is overcast or mostly cloudy. According to the Koppen's climatic classification system, Lashio has Humid Subtropical Climate (Cwa). Temperature and rainfall conditions of Lashio are shown in Table (1).

Table 1 Average Monthly Rainfall and Temperature of Lashio (1980-2019)

	Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec
R.F (mm)	8.74	9.51	15.75	56.95	137.90	198.90	230.95	238.43	192.23	138.85	50.58	9.31
Max(˚C)	26.22	28.67	31.98	33.66	32.63	31.14	30.22	30.39	29.59	29.76	28.07	25.93
Mean(˚C)	15.22	16.97	20.27	23.80	25.45	26.14	25.86	26.16	24.96	23.59	19.90	16.17
Min (˚C)	4.23	5.26	8.56	13.93	18.28	21.14	21.48	21.92	20.33	17.42	11.73	6.40

Source: Meteorology and Hydrology Department, Lashio

Monthly Rainfall Variability of Lashio between 1980 and 2019

In Lashio, from May to October are the months with the most annual amount of rainfall. Generally, May, June, July, August, September and October are the months with the highest amount of rainfall in Lashio. Aprial and November are the months with moderate amount of rainfall in Lashio. January, February March and December are the months with the lowest amount of rainfall in Lashio. See in Table (2&3).

Among the total number of 40-year period, it is found that there are 24 years with rain and another 16 years without rainfall in January. The maximum rainfall was 55.12 mm and the range of rainfall was 55.12 mm. The mean of rainfall was 8.74 mm in January. The standard deviation of this month was 16.02 and the coefficient of variation was 183.26. The precipitation ratio of this month was 638.24.

In February, 21 years were no precipitation whereas 19 years with rain period. The maximum rainfall was 87.12 mm and the range of rainfall was 87.12 mm. The mean of rainfall was 9.51. The standard deviation of this month was 16.92 and the coefficient of variation was 177.87. The precipitation ratio of this month was 927.03.

The highest distribution of March was recorded at 78.23 mm. During 40-year period, 7 years had no precipitation and 37 years had rain. The mean of this month was 15.75 mm and the range of rainfall was 78.23 mm. The standard deviation of this month was 20.48 and the coefficient of variation was 130.02. The precipitation ratio of this month was 496.77.

In April, the average rainfall was 56.89 mm. The maximum and minimum rainfalls were recorded at 115.82 mm and 9.14 mm and the range of rainfall was 6.60 mm. It is found that the monthly rainfall for 20 years was less than the mean rainfall 56.9 mm and 20 years were more than the mean. The standard deviation of this month was 32.34 and the coefficient of variation was 56.79. The precipitation ratio of this month was 566.07.

In May, the average rainfall was 137.92 mm. The monthly rainfall of May for 23 years was less than the mean and only 17 years had more than the mean. The maximum and minimum rainfalls were recorded at 356.10 mm and 34.04 mm. The range of rainfall was 322.07 mm. The standard deviation of this month was 71.83 and the coefficient of variation was 52.09. The precipitation ratio of this month was 233.52.

In June, July and August, it is found that there are 22 years with less than the mean rainfall and only 18 years were more than the mean of rainfall in each month. The average rainfall was

198.88 mm, 251.46 mm and 238.51 mm respectively. The maximum rainfall of June, July and August was 459.23 mm, 411.99 mm and 391.92 mm respectively. The minimum rainfall of June, July and August was 64.00 mm, 103.89 mm and 302.26 mm respectively. The range of rainfall of these months was 395.22 mm, 308.10 mm and 89.66 mm respectively. The standard deviation of these months was 83.61, 77.40 and 69.53. The coefficient of variation in June was 42.04. The precipitation ratio of this month was 198.08. The coefficients of variation in July and August were 33.52 and 29.16. The precipitation ratio of these months was 133.44 and 138.31.

In September, the monthly rainfalls for 17 years were less than the mean and 23 years have more than the mean of rainfall. The maximum and minimum rainfalls of September were 322.83 mm and 56.90 mm. The range of rainfall was 265.94 mm. The standard deviation of this month was 66.95 and the coefficient of variation was 34.83. The precipitation ratio of this month was 138.31.

The highest distribution of October was recorded at 367.03 mm and the lowest distribution had no rain. During 40-year period, one year had no precipitation and 39 years had rain. The average mean of this month was 138.94 mm and the range of rainfall was 367.03 mm. The standard deviation of this month was 87.98 and the coefficient of variation was 63.30. The precipitation ratio of this month was 246.17.

In November, 5 years were no precipitation whereas 35 years with rain period. The maximum rainfall was 225.04 mm and the range of rainfall was 225.04 mm. The mean of rainfall was 48.26 mm. The standard deviation of this month was 51.24 and the coefficient of variation was 101.31. The precipitation ratio of this month was 445.23.

In December, it is found that there are 26 years with rain and another 14 years without rainfall. The maximum rainfall was 72.90 mm and the range of rainfall was 72.90 mm. The mean of rainfall was 1.78 mm. The standard deviation of this month was 14.11 and the coefficient of variation was 151.56. The precipitation ratio of this month was 775.68.

In analyzing rainfall data of Lashio, it is found that there are differences between maximum and minimum rainfall of over the series of expressed in terms of mean. This ratio may give the stability of rainfall with special relationship. Higher the ratio is higher in abnormality in rainfall and vice versa.

Table 2 Numbers of Monthly Rainfall Variation and Precipitation of Lashio

No.	Months	No. of years above of the mean	%	No. of years below of the mean	%	Precipitation Ratio
1.	January	29	72.5	11	27.5	638.24
2	February	28	70.0	12	30.0	927.03
3	March	27	67.5	13	32.5	496.77
4	April	20	50.0	20	50.0	566.07
5	May	23	57.5	17	43.5	233.52
6	June	22	55.0	18	45.0	198.08
7	July	22	55.0	18	45.0	133.44
8	August	22	55.0	18	45.0	138.31
9	September	17	42.5	23	57.5	138.31
10	October	21	52.5	19	47.5	246.17
11	November	24	60.5	16	39.5	445.23
12	December	28	70.0	12	30.0	775.68

Source: Meteorology and Hydrology Department, Lashio

Table 3 Monthly Standard Deviation and Coefficient of Variation of Lashio

No.	Months	Average (mm)	Std	CV
1	January	8.74	16.02	183.26
2	February	9.51	16.92	177.87
3	March	15.75	20.48	130.02
4	April	56.95	32.34	56.79
5	May	137.90	71.83	52.09
6	June	198.90	83.61	42.04
7	July	230.95	77.40	33.52
8	August	238.43	69.53	29.16
9	September	192.23	66.95	34.83
10	October	138.85	87.98	63.36
11	November	50.58	51.24	101.31
12	December	9.31	14.11	151.56

Source: Meteorology and Hydrology Department, Lashio

Annual Rainfall Variability of Lashio between 1980 and 2019

As Lashio is situated on the highland region, it receives more rain than the surrounding areas. According to the rainfall data from 1980 to 2019, the average total annual rainfall of Lashio is 1288.29 mm. See in Table (1& 4).

The temporal distribution of rainfall over the study region was investigated. The pattern of ombrothermic diagram for individual year is unstable varying from unimodal type to bimodal, trimodal and multimodal types. During 40-year period, there are 11 years with unimodal, 20 years in bimodal, 7 years with trimodal and 2 years with multimodal. Nearly all unimodal patterns have much

rain in July (1980, 1994, 1996, 1997, 1998, 2004, 2005, 2012, 2013, 2014 and 2015) but 1997 and 2004 receive much rainfall in September. Although some years have bimodal pattern, rainfall is evenly distributed during the rainy season. In trimodal and multimodal patterns, the rainfall is relatively distributed evenly throughout the rainy season.

During the period of 1980 to 2019, the total annual average rainfall is about 50.72 inches. In some of the years like 1982,1988, 1990, 1992, 1993, 1994, 1996, 1997, 1998, 1999, 2002, 2003, 2005, 2007, 2009, 2010, 2011, 2012, 2014, 2015 and 2019 are under the average total rainfall and the rest years (19 years) were above the average total annual rainfall. Among these years, some of the years -1986 and 2008 are very slightly increased with the average total rainfall of 107.35 mm, but some of the years like 1980, 1981, 1983, 1984, 1985, 1986, 1987, 1989, 1991, 1995, 2000, 2001, 2004, 2006, 2008, 2013, 2016, 2017 and 2018 significantly increased with amounted over 107.35 mm. See fig (1).

During the 40-year period, the average annual rainfall for the period from 1980 to 2019 in Lashio was 107.35 mm with the standard deviation of 91.97 and coefficient of variation was 85.67%. During 40 year period, the highest coefficient of variation (125.87%) was 1012 and the lowest coefficient of variation (70.19%) was 2019. Thus, the range of the two extremes amounted to 55.68%. During the 40-year period, the average total rainfall of Lashio is very fluctuation. Therefore, it is noted that the rainfall receiving in Lashio is fluctuation. See table (4).

Table 4 Yearly Standard Deviation and Coefficient of Variation of Lashio

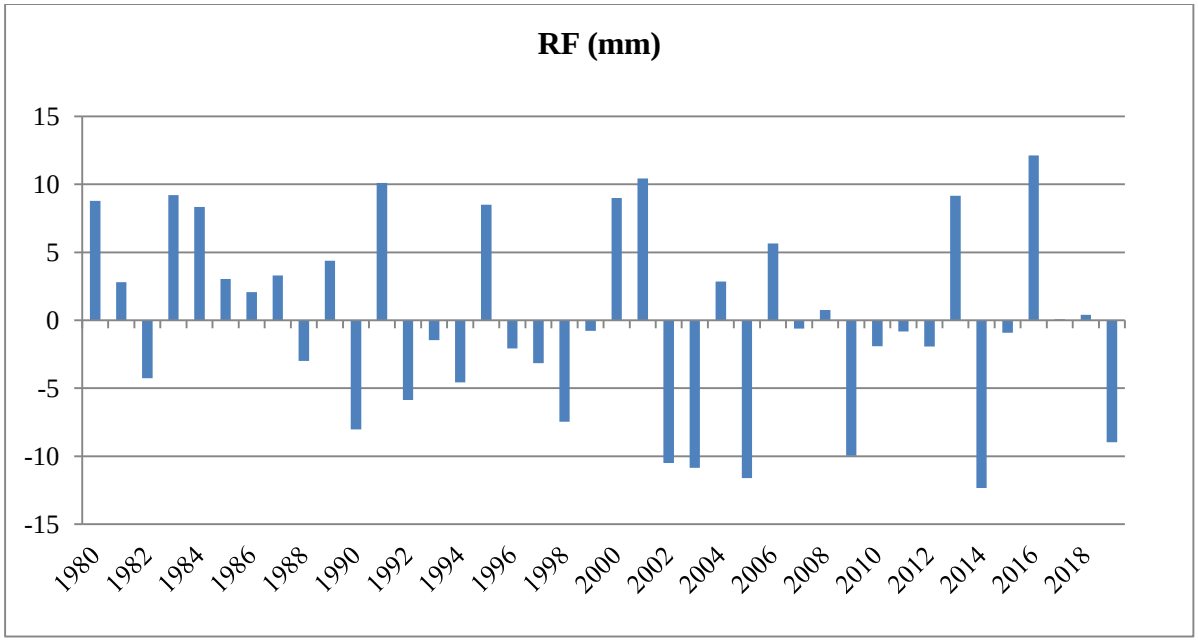
Year	Rainfall(mm)	Std	CV		Year	Rainfall(mm)	Std	CV
1980	1511.05	138.57	110.05		2000	1516.63	118.71	93.93
1981	1359.15	101.27	89.41		2001	1552.96	146.29	113.04
1982	1179.83	117.79	119.80		2002	1021.84	87.74	103.04
1983	1522.22	94.55	74.54		2003	1012.95	94.16	111.54
1984	1500.12	130.20	104.15		2004	1360.42	109.43	96.53
1985	1365.50	112.78	99.11		2005	993.90	94.41	113.99
1986	1341.12	129.35	115.74		2006	1432.05	114.50	95.94
1987	1371.85	123.64	108.15		2007	1273.05	110.46	104.12
1988	1212.60	82.38	81.52		2008	1307.34	96.46	88.54
1989	1399.29	125.29	107.45		2009	1035.30	89.26	103.46
1990	1084.58	86.77	96.01		2010	1240.03	98.06	94.90
1991	1544.57	118.68	92.20		2011	1267.46	97.89	92.68
1992	1139.70	95.52	100.58		2012	1239.01	129.96	125.87
1993	1250.95	98.55	94.54		2013	1520.95	142.35	112.31
1994	1172.21	86.39	88.44		2014	975.11	99.88	122.91
1995	1504.19	118.75	94.73		2015	1265.17	127.58	121.00
1996	1235.46	98.91	96.07		2016	1595.88	123.17	92.62
1997	1208.28	112.88	112.11		2017	1290.32	83.53	77.69
1998	1098.80	82.44	90.03		2018	1298.70	100.29	92.67
1999	1268.48	96.40	91.20		2019	1060.70	62.04	70.19

Source: Meteorology and Hydrology Department, Lashio

Rainfall Trend Analysis of Lashio

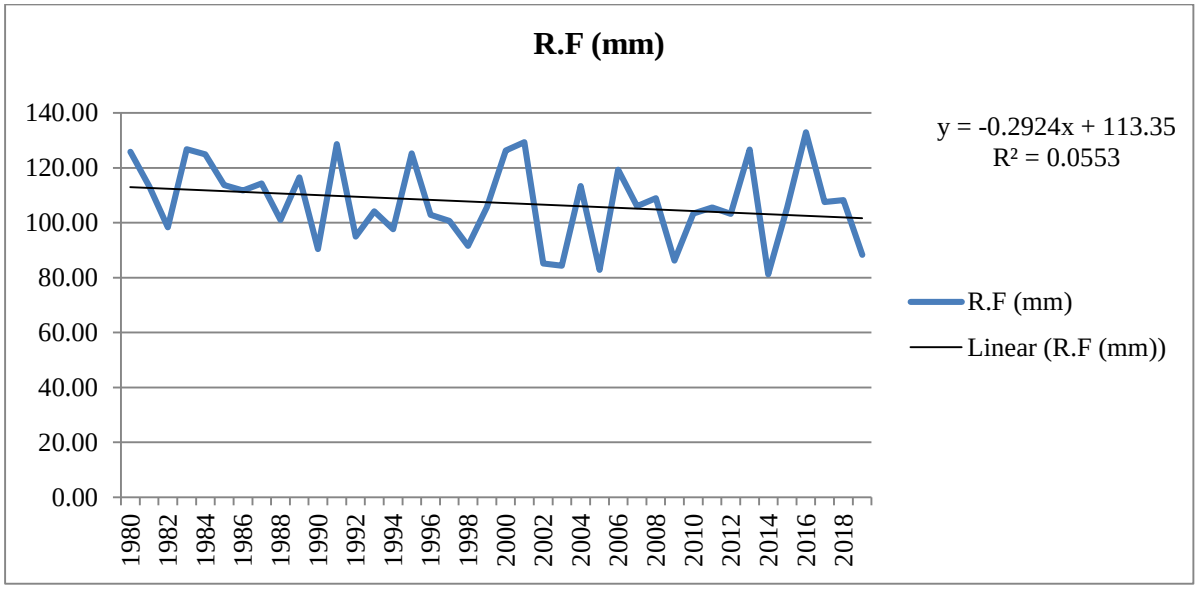
Trend line analysis is a useful tool to depict the changing pattern of time series data. Long term rainfall records are essential to study the climate of an area. Lashio is carried out first to understand the evolution of rainfall was how much increasing and decreasing during 40-year period.

The advantage of this method is that it provides quick visual observation of the presence trend in a given time series. Moreover the use of the graphical approach for trend analysis is simple. The visual method of determining trends from a graph is very subjective therefore statistical method can also be used. Statistical methods were used to test the statistical significance of the observed trends in a time series. The results of trends analysis from graphical method were categorized into two categories namely; increasing trends (positive) and decreasing trends (negative). The monthly analysis of rainfall data for Lashio station showed that there are increasing (positive) trends in January, March and July during the 40-year period from 1980 to 2019. However, the rest of the months- February, April, May, June, August, September, October, November and December depicted decreasing (negative) trends. To examine long term trend of rainfall for this study total annual rainfall records for the period from 1980 to 2019 is used. In summary result from all graphical methods showed decreasing (negative) trend given by the equation $y = -0.2924x + 113.35$, $R^2 = 0.0553$. See fig (2).



Source: Based on Table (4)

Figure 1 Annual Rainfall Abnormality of Lashio



Source: Based on Table (4)

Figure 2 Annual Rainfall Trend in Lashio Township

Conclusion

This study is undertaken to understand general climatic condition, rainfall variability and trend in Lashio Township. This paper analyzes the rainfall data of 40 years of Lashio which plays a significant agricultural and hydrological contribution in the over growth of Lashio Township. These will provide information on rainfall variability of the township and could be used as input for the local adaptation planning and to develop adaptation strategies for the study area.

The air we breathe is obtained from the atmosphere; the water we drink originated from precipitation and the food we eat has its origin in photosynthesis all of which attributes of climate. Climate and climatic variation exert a tremendous influence on society. The impact of climate and its variation may be positive or negative. The climate and society interface may be thought of in terms of adjustment that is the extent and ways in which society function in a harmonious relationship with its climate.

The climate of Lashio is marked by considerable inter-yearly fluctuations in precipitation. Such a study may be further detailed by analysing the daily data instead of monthly and yearly applying other climatic elements and pointing out the variation patterns by months and years which are most prone to variability those relatively or entirely free from it. This study indicates that there is variation in the climate of Lashio following rainfall variability and a lot of negative impacts have been created by this climatic phenomenon in the area. It is expected that the development planning for Lashio will be supported by studying the detailed patterns of variability in climatic elements. This study will be of assistance to better inform farmers as well as agricultural decision makers, also study of temporal fluctuation and trends of rainfall may be used to characterize climatology of the area.

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We would like to express the deep gratitude to Dr. Kyaw Tun, Rector, Lashio University and Dr. San Yu Maw, Professor, Head of the Department of Geography, Lashio University for their kind permission of this research paper. We would also like to acknowledge those who academically and technically are involved in our research and those who co-operated in helping us in this study.

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POTENTIAL AND CHALLENGES FOR SUSTAINABLE TOURISM DEVELOPMENT IN DAWEI, MYANMAR

Zin Nwe Myint[1] and Frauke Kraas[2]

Abstract

Myanmar had been encouraging tourism since 1988 with the change to a market-oriented policy. To support tourism development, new tourism law and regulations had been established. After 2010, change in the political system gave more power to region and state governments to develop own economic profiles. High expectations to support economic development were set in tourism. Many regional governments encouraged the improvement of touristic infrastructure and sites s. Dawei, capital of Tanintharyi Region, and its surrounding area has great and almost yet underdeveloped touristic potential. It is among the most promising emerging touristic sites of the country. Against this background, this aim of the study is to examine the current situation of tourism development in Dawei in order to understand the potential and problems of further development. Empirical fieldwork is based on a mixed-methods approach, combining quantitative statistical data and field observation with predominantly used qualitative methods of 72 semi-structured interviews with different stakeholders from the tourism sector. Finally, an assessment of the current situation and recommendations for further sustainable tourism development of Dawei are combined.

Keywords: sustainable tourism development, Dawei, tourist potential

Introduction

According to UNWTO (2016) 104 million international tourists visited Southeast Asia in 2015. Tourism contributed over $108 billion to the region's GDP and many international institutions emphasized the importance of tourism to poverty alleviation. However, international tourism rarely brings benefits to the local communities (Hampton et. al., 2017) as it is usually dominated by international hotels and service providers serving the mass tourism market (Scheyvens, 2011). Further, the way in which tourism development is driven by international tour operators, has contributed to widening regional disparities within the countries and regions. In recent years, concepts, policies and approaches to tourism development have started to change. Concepts of sustainable tourism are growingly gaining attention in tourism planning policies by many governments (Hanafiah et. al., 2016: 407). The United Nations defined sustainable tourism development as meeting the need of the tourists and host regions while protecting the opportunities for the future whereas resources should be managed in a way that economic, social, cultural, ecological and life support systems are properly maintained (2001: 12).

With the new government reforms after 2010, the Ministry of Hotels and Tourism aimed to support the socio-economic development of local people and the local private sector in a sustainable and inclusive way. Tourism policies were adopted with the Responsible Tourism Policy in 2012 with nine major aims (MoHT, 2012: 8). The new approach seeks to manage tourism sustainably with the aim to combine maximised economic, social and environmental benefits with minimising costs to destinations. Encouraging economic growth, environmental sustainability and social justice alike were declared key targets of the new strategy. It focuses on the responsibility of role-players in the tourism sector and destinations in general to take action to achieve sustainable tourism development (MoHT, 2012: 4). The central government also gave new power to the governments of the states and regions to develop tourism sustainably (https://tourism.gov.mm/mm/objectives/).

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Subsequently, the Tanintharyi Regional Government encouraged tourism development and organised numerous workshops to support tourism development in line with the government policy. Within the Master Plan for Tanintharyi Region, Kawthaung and Myeik were selected as main tourism areas. The supreme islands and beaches of Myeik Archipelago, with more than 800 islands, was selected for its richness in natural resources, corals and traditional cultures attractive to tourists (MIMU, 2014). Dawei and surroundings were designated as location of a new Special Economic Zone (SEZ) and deep sea port.

However, Dawei also has very high potential as prime future tourism destination. Reports and news media raise expectations that Dawei could most likely become a new magnate for international tourists as soon as the highway crossing border with Thailand were finished. More than 330,000 visitors had already passed through the border crossings of Tanintharyi Region in 2016 (Ei Ei Thu, 2018) out of which about 45,000 crossed via the Htee Kee border pass to Dawei (MoHT Dawei, 2017). Given its proximity to Bangkok, the world's most frequented urban tourism hub, and the established extended tourism corridor to Kanchanaburi, it is to be expected that international tourists visiting Thailand would extend their discovery to Tanintharyi Region via Dawei's Htee Kee border crossing.

Against this background, the main research questions are: (a) What potential does Dawei offer for tourism development? and (b) How can this potential be developed in a sustainable and inclusive way benefitting local people?

Aim of the study

The aim of this research is to examine the actual situation of tourism development in Dawei based on sustainable tourism development criteria. The objectives are: to examine the current situation of tourism development in Dawei, to explore the ecological and social potential for further tourism development of Dawei and to give suggestions for sustainable tourism development of Dawei that benefit the local societies.

Dawei: an emerging tourist area

Dawei is located at the southern coastal strip of Myanmar. It is the capital of Tanintharyi Region since 1974, 630 km (391 miles) away from Yangon by motor road, 16.6 miles north of the mouth of Dawei River. Dawei Township has an area of 4268.3 sq. km (1648 sq. miles) and is composed of 15 wards and 17 village tracts (Department of Population, 2017 and GAD, 2016). It has a population of 125,605 (Census 2014) and 136,783 in 2020 (https://worldpopulation-review.com/). About 64% of the population lives in urban area, mainly in Dawei.

Dawei's rich historical background dates back to the 11th century. Numerous ancient pagodas in and around Dawei are attracting domestic tourists. Dawei is also one of the main seaports in Tanintharyi Region, historically also an important trading port. Fishery is the main part of the economy. Additionally, many fishing villages along the coastline now become tourist attraction sites.

Methodology

The study is based on a mixed-methods approach with a strong qualitative social research focus. First, a preliminary investigation of available literature, statistics and reports and a first field visit in Dawei were made. Based on this, guiding questions for semi-structured interviews were created in order to conduct interviews with local stakeholders in tourism and authorities from local government institutions. Almost all hotel and guesthouse owners or managers were interviewed. Further in-depth interviews on potential and challenges of tourism development in the Dawei area

were conducted as second appointment with those willing to share their experience as key informants. Among them were the manager of a large hotel and vice-presidents of the Association of Local Tour Guides of Dawei, and owners of transport services and restaurants. Further interviews with chief authorities of the Tourism Promotion, General Administration and Immigration Departments focused on strategies and future trends of tourism development, with special attention on border and cross-border international tourism in relation with the border pass and town of Htee Kee. A total of 66 interviews were conducted during the third week of April 2017 and additional fieldwork with 6 interviews in late April 2019. All interviews were systematically coded and transcribed.

Out of the total, 17 interviews were made with domestic and international tourists. These interviews reflect the perceptions of the tourist on potential of Dawei. Based on this, a questionnaire survey was made for a better understanding of the perception of tourists on Dawei. The questionnaires were distributed in the largest seven hotels and two guesthouses with a request to the managers to distribute to their guests. In total, 47 questionnaires were collected and analysed. Finally, all primary data from field observation, interviews and questionnaires were used for a comprehensive SWOT analysis.

Potential for tourism development of Dawei

Attractions around Dawei

Dawei possess different types of tourist attractions, differently attractive for domestic and international tourists. Domestic tourists prefer to visit religious sites, some enjoy especially Maung Magan beach. For international tourists, the main attractions are the almost untouched tropical beaches, traditional handicrafts and Dawei town. Further, several ancient towns near Dawei are of interest to international and national archaeologists and historians. Some business tourists are connected with the emerging Special Economic Zone.

Shin Koe Shin Pagoda

Improved motor roads and security have allowed an increase of domestic tourists to Dawei attracted by the nine famous pagodas which names start with "*Shin*". Domestic tourists believe that if they worship in all of these *Shin Koe Shin* pagodas, their wishes will be fulfilled (Interview-DW01, 2017). These nine pagodas are Shin Pin Khayu, Shin Moakhti, Shin Oak Aow, Shin Dat Wel Pagodas in Dawei Township, Shin Maw, Shin Tauk Htein, and Shin Zalon in Long Lon Township, Shin Tauk Pon and Shin San Taw Pagodas in Thayet Chaung Township and Yay Phyu Township (Maung Thar, 2017).

The most famous of these are Shin Moakhti Pagoda located south of Dawei, Shin Dat Wel Pagoda in the north and Shin Maw Pagoda located on a promontory south of Dawei. Lawka Tharaphu Pagoda, a 74-m long reclining Buddha, remains one of the most popular tourist destinations in Dawei. Myaw Yint Pagoda near the Maung Magan Beach, another popular tourist destination, is located in the centre of the island and was built by assembling huge rocks, making it extremely attractive to tourists. Each of these pagodas is unique and famous pagoda festivals during October attract domestic tourists (Maung Thar, 2017 and Interview-DW01, DW46, DW50, 2017).

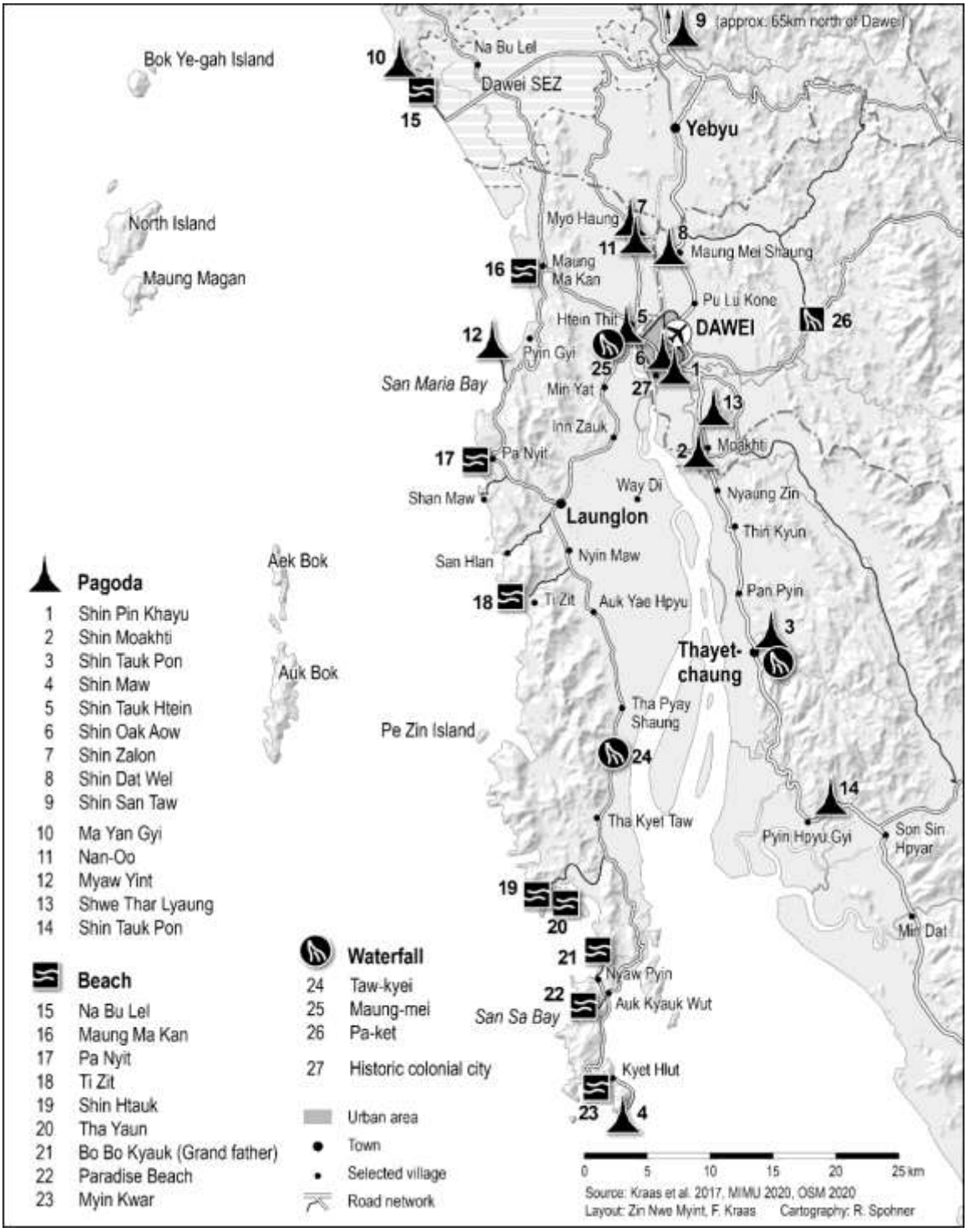

Figure 1 Tourist attraction sites around Dawei

Ancient towns near Dawei

The Dawei area has a long history, documented by ancient settlements which are now left as cultural heritage. They are not yet well known but are familiar to a limited extent to archaeologists and historians. According to Moore (2011: 4-5), the Dawei Cultural Zone stretches about 100 km in a north-south direction, from Aungtha Waddy to Thayet Chaung.

The largest ancient site is **Thagara,** known as *Myo-haung*, old city, which is located 11.6 km north of Dawei. It was included in a list of 47 ancient sites of Myanmar in 2012 (Kyaw

Naing, 2012). With an area of 281 acres, it has an oval-shaped walled site. It is densely populated inside the walls, while the area beyond the wall is primarily rice fields. Two main pagodas are situated within the walled area, Shin Zalon and Nan-Oo Zeidi. Until recently, Thagara was maintained as a very traditional town (Winn Myintzu et. al., 2019: 3). The pure lifestyle deserves very careful handling if opened to tourism, in order to not affect the local communities. Another ancient city is **Mokti**, dating back to the tenth to thirteenth centuries, located 9.6 km south of Dawei near Shin Moakthi pagoda. Its rectangular wall stretches about 800 m from east to west and north to south (Moore, 2011: 9). Once, it shortly functioned as port, under the protection of independent kings, courts, traditions of sovereignty and localism (Moore and Soe Thainkha, 2019: 150).

Apart from these two main ancient sites, five further, smaller ancient sites are scattered around Dawei peninsular. These are Min Yat (opposite Dawei town), Weidi (south of Min Yat at the head of the Dawei River estuary), Taungkwe (on the west side of the southern peninsula), Kyet-yet-twin (on the east side of the southern peninsula) and Thin Bone Kyun (on the east side of the southern peninsula) (Moore, 2011: 10). Stone and earthen artifacts have been found leading to the assumption that a lateritic culture flourished during the 16th to 19th centuries. These sites have minimally explored and potentially, these ancient sites could attract more international scholars and tourists to Dawei.

Beaches and islands near Dawei

Apart from the popular Maung Magan beach, dozens of untouched natural white sand beaches exist along the coastline near Dawei, particularly on the peninsula towards **Dawei Point.** Maung Magan beach, 12 km west of Dawei, has been a famous destination for domestic tourists for 40 years. Its white sand, the casuarina trees (*Casuarina equisetifolia*) along the long shore line, the shallow and gentle continental shelf that allows safe swimming and traditional fresh seafood restaurants at the beach are the main attractions of this place (DW66, 2017). A hot spring in Maung Magan village also attracts tourists.

Among many other splendid beaches, the white sand beach of Nabule lies 18 km north of Maung Magan. At its northern part a hillside pagoda allows beautiful scenery. San Maria Bay, about 45 minutes by car south of Maung Magan, is located on the road to Myaw Yint Pagoda**.** The pagoda's shrine is on a headland 500 m north of San Maria Bay, on a long footbridge to the sea, with beautiful scenery. Tizit Beach, further south beyond Dawei, can be reached on the way **to** Launglon village**.** A number of beautiful fishing villages lie by the wayside. Further south of Tizit, many small beaches and islands form a line on Dawei peninsula. The most beautiful among them are Grandfather Beach (Pho Pho Kyauk), Shin Htauk, San Sa Bay, Myin Kwar. Shin Maw Pagoda at the tip of the peninsula looks like the crowning glory. All the beaches are almost untouched. However, infrastructure is very limited and roads leading to the beaches are bad, also for the surrounding rural settlements and fishing villages. Very limited beach huts (like bamboo bungalows) are available as accommodation at some beaches. Most visited sites are Myaw Yit Pagoda and Maung Magan, Grandfather, Nabule, Paradise and Ti Zit Beaches (Interview-DW04, DW47, 2017).

Many islands of various sizes have ecologically rich landscapes with many diverse species of fauna and flora. Lounglone Bok Island and Pe Zin Island on the Andaman Sea are the most visited islands in Dawei. Tourists can engage in activities such as snorkeling, fishing and boat trips. The Moscos Islands are a string of small unpopulated islands about 15 km off the coast. Some of these untouched islands can be reached by boat from Maung Magan village even though their accessibility is as yet too limited (Interview-DW056, 2017).

Fishing villages

The numerous traditional fishing villages, such as San-Hlan, Pa-Nyit, Hsin-phyu-taing and Nyau-pyin Villages offer interesting insights for domestic and international tourists (Valentin, 2017).

Waterfalls

Several waterfalls, such as Taw-kyei Waterfall at Taw-kyi Village, Maung-mei Waterfall at K-myaw-gyi Village in Laung Lon Township, Tha-yet Chaung Waterfall, Pa-ket Waterfall at Pa-kari Village of Dawei Township and the 12 miles Waterfalls at Yay-phyu Township offer pleasant recreation sites (Valentin, 2017).

Dawei urban heritage

During colonial time, Dawei was known as Tavoy. In 1989, the city's name was changed to Dawei and the name of Tenasserin was changed to Tanintharyi Region (GAD, 2016). In the old parts of Dawei town interesting colonial architecture, with many old wooden, thatch-roofed bungalows and brick and stucco mansions can be explored. This authentic urban heritage is an attractive asset for domestic and international tourists. Further, the lively Central and Mingalar Markets are of interest to tourists.

Cultural museum of Dawei

A new cultural museum, opened in November 2015, displays cultural and many ancient Pyu artifacts excavated from ancient sites. Traditional handicrafts from the Dawei area such as the making of mats, pipes, wooden shoes, traditional customs and dances etc., are explained and displayed. Until April 2017 no entrance fees were collected. Then 200 Kyats were charged for domestic visitors (rising to 300 Kyats in 2019) and 5000 Kyats for international tourists. If international tourists want to visit the museum, they need to contact tour guides. In 2017, between 100 and 180 international tourists per month visited the museum (Interview-DW45), in 2019 already between 200 and 250 visitors per month were registered (Interview-DW112, 2019).

Traditional crafts

Particular interests especially to international tourists are sites where traditional crafts are produced (DW106 to DW111 in 2019). Most attractive because of their uniqueness and rarity are the many cashew nut, cheroot and fish cracker factories in Dawei. Local potteries, weaving (especially local *loungyis*), wood carving and wooden boat-making sites are also of great interest. Furthermore, tourists can explore the production of brooms, wooden shoes, sunshades and grass-mats. While in many parts of the world traditional handicrafts have been replaced by the industrial fabrication of goods, often using substitutive materials, here local crafts-persons still preserve and use their skills.

Dawei SEZ

In 2008, the plan to establish a Dawei Special Economic Zone (DSEZ) north of Dawei was introduced and a Memorandum of Understanding was signed with Thailand. The development was halted in 2013. In 2015, it was then transformed into a trilateral project between Myanmar, Thailand and Japan (Blank/Efron/Migacheva, 2019). In October 2019, the Myanmar government invited international investors, such as from Singapore, India, Malaysia, Thailand, China, South Korea, Vietnam and Australia (Aung Loon, 2020). After completion, the DSEZ is expected to be one of the largest industrial parks in Southeast Asia, eight times larger than Thilawa SEZ (with 196 sq. km). DSEZ is located on the northern bank of the Dawei river estuary, about 630 km south

of Yangon and about 138 km west of the Myanmar-Thailand border at Baan Phu Nam Ron. Thus, it will be linked via Bangkok with the Eastern Seaboard (Thailand) and further the Phnom Penh to Ho Chi Minh axis (Isono/Kumagai 2013). Dawei Deep Sea Port is part of the SEZ development project. DSEZ and its port has a huge potential to attract more business tourism to Dawei.

Dawei and Kanchanaburi: Sister Cities

Due to improving accessibility, more people are crossing the border in both directions. In order to mutually tap economic opportunities, it has been proposed that Dawei and Kanchanaburi should co-develop as Sister Cities along the 160 km Phu Nam Ron – Dawei route. If this proposal is approved, the route would connect Dawei Deep Sea Port at the Andaman Sea, which might become one of the largest ports in the region, via a land bridge with Laem Chabang Deep Sea Port at the Gulf of Thailand (https://www.go-myanmar.com/dawei-tavoy).

Arrival of tourists in Dawei

All interviews with travel and tour companies, hotel and guesthouse owners, restaurants and cafés underline a remarkable, accelerating number of tourist arrivals since 2011 and even further after 2015. The peak times of arrival of domestic tourists usually over the Thingyan (water festival) period, during which all hotels, guesthouses and monasteries in Dawei are completely occupied by tourists. As this is one of the longest holiday periods in Myanmar, people from different parts of Myanmar visit Dawei – which is too far away from central Myanmar for most travelers to access during shorter holiday periods. About 500 to 850 45-seater buses usually arrive in Dawei during the *Thingyan* period. The second peak season for domestic tourists is during the Christmas holidays and the Thadinkyut festival period in October (Interview-DW16, DW47, 2017). The number of domestic tourist to Dawei increased about three times during the last couple of years due to improved motor roads and security (Interview-DW16, DW16, 2017 and DW106, 2019). The Ministry of Hotel and Tourism in Dawei (Dawei MoHT) had estimated the number of domestic tourist to Dawei has obviously increased, about 10 times, as shown in Table 1.

Table 1 Arrival of domestic tourists to Dawei

Year	Total Arrival
2013	7116
2014	15824
2015	29004
2016	60426
2017	88164
2018	79608
2019	69493

Source: MoHT, Dawei, 2020

The number of foreign visitors in the Dawei area has constantly increased over the last few years: while 12,025 foreigners arrived in 2013, the numbers increased to 58,853 in 2015. The highest numbers of arrivals are counted during the dry season between November and April. The majority are foreign individual travelers (FIT) while package tourists are very rare (Myitmakha News Agency, 2016). According to a news report, 65% of both local and foreign tourists prefer to visit the beaches, 30% prefer eco-tourism and only 5% pilgrimage (Ei Ei Thu, 2018).

As the Htee Kee border gate is relatively close to Bangkok, international tourists use the improving connectivity to Dawei. According to Dawei MoHT, international tourists entering Myanmar from the Htee Kee border gate increased from 42,224 in 2014 to 46,896 in 2015. Compared to Myeik and Kawthaung, Dawei is the nearest access point to Yangon so that especially Thai tourists choose Dawei as initial destination (see Table 2) before traveling to the country's religious and commercial capital, Yangon, from where they can continue to classical tourist sites in central Myanmar (Ei Ei Thu, 2018).

Table 2 Arrival of Thai visitors via Htee Khee border gate from May 2013 to 2018

Months	**Year**					
	2013	**2014**	**2015**	**2016**	**2017**	**2018**
January	nil	1160	433	1117	853	958
February	nil	1232	602	1306	535	686
March	nil	1101	395	1409	667	744
April	nil	732	449	1522	888	706
May	65	492	479	1191	660	1093
June	216	585	740	661	546	477
July	723	637	383	541	485	413
August	576	632	514	357	538	438
September	830	689	613	511	400	545
October	844	751	499	434	643	814
November	1217	1397	691	600	722	1073
December	1077	728	1060	864	821	884
Total	**5,548**	**10,136**	**6,858**	**10,513**	**7758**	**8831**

Source: Ministry of Hotels and Tourism, Dawei District, 2017, 2019

Since 2015, caravan tours have also been allowed by the Ministry of Hotels and Tourism (MoHT). To date, staff from Dawei MoHT have guided more than 40 caravan trips that passed through Dawei. The number of caravan cars varies from one to 15 cars in one tour. Normally, they stop at hotels due to the lack of proper places with required infrastructure for caravans halts (Interview-DW01, 2017).

Accessibility

Dawei can easily be reached by motor roads, rail, air and water-way. The national high-way from Yangon via Mawlamyine and Dawei to Kawthaung connects Dawei with other destinations in the north and south. Dawei can be accessed from various parts of Myanmar by motor road. The distance from Dawei to Yangon (564 km) usually takes about 11 hours by express bus, from Dawei to Myeik about 8 hours, further to Kawthaung another 14 hours. As the motor road has been much improved during the last few years, far more domestic tourists than in previous years travel to Dawei. During the dry season of 2016-2017, 310 buses from Yangon to Dawei and further from Dawei via Myeik to Kawthaung were organised by 29 travel associations. Due to the upgraded roads and modern highway buses with advanced technology travel time has been much reduced in recent years (Interviews-DW04, DW26, 2017 and DW11, 2019).

The Yangon-Dawei railroad runs parallel to the motor road, ending at Dawei. It was constructed in 2005 and completed in 2006. For the distance of 628 km, the travel time from Yangon to Dawei takes about 27 hours (Kyaw Naing, 2012) which is beyond convenience for both international and domestic tourists.

By water, there are two routes, northwards from Dawei via Mawlamyine to Yangon and southwards from Dawei via Myeik to Kawthaung. Speed boats are running southwards on a daily basis by private companies. These are used by considerable numbers of passengers in order to reduce the travel time (Kyaw Naing, 2012). Further, daily flights connect Dawei with Yangon, and also with Myeik and Kawthaung.

Dawei lies relatively close to the border with Thailand. A constantly improved motor road connects Dawei in the east with Myitta town and with the border town of Htee Kee. Its trade centre at the border opened in March 2013 (DW01 and Dawei MoHT, 2017). Even if the distance between Dawei and Htee Kee is only 160 km (97 miles), travel time in the dry season is between five and six hours by car due to the road conditions. From Htee Kee trade centre the road to Bangkok – running via Phu Nam Ron and Kanchanaburi (1.5 hour drive) to Bangkok (further 2.5 hour drive by car) – is more convenient. Four buses per day run from Kanchanaburi to the border town of Phu Nam Ron. Motorbike taxis are also available here. From **Dawei to Thailand**, daily minibuses to Htee Kee can be booked through most hotels and guesthouses in Dawei (https://www.go-myanmar.com/arriving-and-departing-over-land).

Accommodation

Until 1995, there was only one guesthouse in Dawei. After the government began to encourage tourism development and with the improvement of motor road conditions and security, tourist arrivals to Dawei gradually increased, especially in the last few years. Until 2012, three hotels with a total capacity of 61 rooms were opened (Kyaw Naing, 2012). By 2020, with increasing numbers of hotels and guesthouses, the total room capacity had increased to 614 rooms (Table 3). Additionally, some guesthouses under the license of the Township Development Committee, had up to 15 rooms of various sizes (Dawei MoHT, 2017).

Moreover, many domestic tourists usually stay at monasteries free of charge or for a little donation to the monastery. During Thingyan holidays (April), all the monasteries in Dawei are completely crowed and even some schools have to be used as accommodation for visitors (Interview-DW01, DW30, 2017).

Table 3 Number of hotels and guesthouses in Dawei in 2020

Year	Hotel	Guest House	Total number of rooms
2013	2	nil	90
2014	8	1	358
2015	8	1	358
2016	10	2	432
2017	10	4	461
2018	11	4	483
2019	11	5	503
2020 July	14	6	614

Source: MoHT, Dawei, 2020

Food services

A special touristic asset in Dawei is its own traditional food culture. Among the many restaurants and café, most are below standard for international visitors, even though some restaurants started to upgrade their services in the 1990s. Also, most of the restaurant owners usually expect domestic tourists (Kyaw Naing, 2012); which is still true in recent years for the majority of the restaurants (Interview-DW101, 2019). With further improvement efforts of hotels and guesthouses, higher standards of food services are gradually reached and some high standard restaurants opened after 2015 (Interview-DW16, DW22, 2017) and in 2019 already five were explicitly recommended (Interview-DW101, 2019).

Infrastructure

The most important need for tourism development in Dawei is sufficient and reliable electricity supply. In 2017, the price of electricity in Dawei was 300 Kyat per unit, whereas in Yangon it was 50 Kyat per unit. In consequence, most of the hotels and guesthouses cannot reduce room rate as they have to pay for expensive diesel engine for electricity supply. Some guesthouses cannot supply 24 hours electricity but only until 9:00 or 10:00 p.m.. Restaurants also face difficulties to store food appropriately (Interview-DW59, DW65, DW66, 2017).

Furthermore, the problem of shortages in water supply during the dry season and in some part of Dawei urban areas was mentioned. Also the sidewalks and internal roads are narrow and partly in bad situation which often is causing road accidents (Interview-DW47, 2017).

Security, tourism policies and tourism governance

Security being among the most important issues in any tourism development, since several years Dawei is safe for tourists for any place to visit. Although very limited number of tourism police (only four) are existing, the whole area is safe for tourists from threat or crime. Local communities and voluntary groups also care for the tourists especially at Maung Magan Beach (Interview-DW27, DW48, DW65, 2017 and DW106, 2019).

A particular problem is the unclear tourism policies on the national level and the regional (Tanintharyi Region) and local levels. Unclear sharing of responsibility between the regional and national governments creates numerous problems, such as in respect to functional processes, like the extension of hotel licenses, which are difficult, time consuming and cumbersome. Even though the Tanintharyi Region Tourism Development Committee organizes the procedures, a lack of information and deficits in power sharing processes and functionality of hinder decision making (Interview-DW15, DW50, DW56, 2017).

Divergent understanding of “zoning” in tourism planning create problems and gaps between government authorities, business people, tour guides and local environmentalist (Interview-DW50, 2017). A lack of basic zoning for types of tourist planning and infrastructure in Dawei leads to coordination problems, such as lacking construction guidelines for hotels and guesthouses or the establishment of proper waste management systems. Responsibility among different institutions drives local people into taking the initiative in waste management (Interview-DW56, 2017).

Discussion: Potential and challenges for tourism development in the Dawei area

Tanintharyi Region as a whole has, as discussed, huge potential for tourism development. Since the government and the private sector have started cooperation, these potentials have been explored and gradually expanded (Thiha Ko Ko, 2019). However, for sustainable tourism development, a comprehensive plan and proper guidelines are needed for the whole Tanintharyi

Region. Building upon these, further specific place-based management plans are needed for each local area, such as Dawei, Myeik and Kawthaung. Like in many tourism studies, a systematic SWOT analysis provides a deeper understanding of the strengths, weaknesses, opportunities and threats, built on which feasible suggestions for more sustainable tourism development can be established. An initial systematic SWOT analysis for tourism development in Dawei shows numerous unique assets (Table 4).

Table 4 Assessment for sustainable tourism development of Dawei

Components of tourism		Strengths (internal)	Opportunities (external)	Weaknesses (internal)	Threats (external)
Attractions	•	• Natural and untouched beaches • Famous Shin Koe Shin Pagodas • Colonial buildings/ urban heritage • Ancient cities • Traditional fishing villages • Hot spring • Water falls • Rich biodiversity • Mangrove ecosystems • Coral reefs	• Many potential eco-tourism sites • Strong community participation and desire for tourism development • Functioning local business community	• Lack of knowledge on environmental conservation • Skills in the tourism sector • Lack of budget in local communities • Preparedness of the local people • Lack of linked touristic offers	• Deforestation • Depletion of biodiversity • Growing socio-economic disparities • Mistrust in local government institutions • Land grabbing
Accessibility	•	• Good north-south motor road connections • Rail connection with Yangon • Frequent waterway connections • Airport	• Dawei deep sea port and SEZ • Close to border with Thailand	• Delay in construction of Dawei SEZ • Road connection to Thailand not yet optimal	• Uncertain foreign direct investment (both in tourism and industry) • Possible dependency on foreign investment
Accommodation	•	• Increasing number of hotels and guesthouses • Increasing level of quality in accommodation • Reputable monasteries	• Interest by business people in investing in hotel sector • Qualification of good tour guide	• Relatively high room rates (in Myanmar in general) • Low standards of accommodation • Little collaboration between hotel and guesthouse owners	• Conflicting land use: DSEZ versus tourism • Potential loss of tourism market
Infrastructure	•	• Improved motor roads • Improved airport and port facilities	• Closeness of border to Thailand • Establishment of Dawei SEZ	• Insufficient electricity supply • Water supply problems in dry season	• No or low investment in Dawei SEZ

Components of tourism		**Strengths (internal)**	**Opportunities (external)**	**Weaknesses (internal)**	**Threats (external)**
		• Improved connectivity of railway		• Protests by local people on many construction sites	• Dominance of foreign investors
Human Resources	•	• Friendliness and hospitality of local people • Thai language skills in the population • University of Dawei can support upgrade of knowledge and skills	• Return of migrant workers with foreign skills • Cultural closeness to Thailand	• Low command of English language • Low level of skills and experiences in the tourism sector	• Lack of local workers because of labour migration to other countries • Neglect of local population in land compensation and fair share
Government/ Institutional policies	•	• Strong willingness from government for tourism development • Strong commitment of local administration	• Encouragement from government for tourism development • Increased power of regional government	• Inconsistency of policies between local government institutions • Slow administrative procedures	• Change of policies if incompatible • Adoption of irrelevant policies

Method source: SWOT method based on Gutierrez et al. (2005). Data source: Interviews with local institutions, experts and (inter)national tourists in 2017 and 2019, additional phone interviews in 2020.

As tourism development in Dawei mainly depends on natural landscapes, such as beaches and forests, eco-tourism bears high potential. In order to ensure the long-term sustainability of the area, proper protection and conservation of the environment should be given top priority in capacity-enhancement programs for community participation and in the establishment of a responsible tourism development strategy.

Detailed operational guidelines are also needed, to provide baselines for the types of boats and vehicles to be licensed to transport tourists and to promote locations for community-based tourism. Safety should be fully guaranteed in all respects. Procedures for emergency cases – like boat accidents, health-related emergency care etc. – should be prepared efficiently. In all cases, competent management is essential (Si Thu Aung Myint, 2019).

The involvement of communities is particularly crucial to the success of tourism development while the implementation of responsible tourism and residents' attitudes may directly affect the development of the tourism industry. However, the central principle of community participation in planning tourism development has proven difficult to achieve (Hanafiah et al., 2016). For proper responsible tourism development with community participation, part of the profit must be used to upgrade the living standard of the local people. Local people should be given priority with job opportunities.

Conclusion

Myanmar is encouraging tourism to be a major component of the state economy. New laws, rules and regulations have been established and now a responsible tourism policy has been adopted with the goal of fostering sustainable tourism development. Residents play a pivotal role as primary stakeholders in tourism development. Local community support is the key element of any successful tourism development – as tourism planners and other authorities engaged in the tourism industry have to be concerned with the communities' views on development plans. However, listening to the local people's perceptions and desire in planning processes for tourism development is yet very rare in Myanmar. This should be changed in the future to allow mutual benefits for both local people and investors – and to achieve long term sustainable development. Further detailed studies are needed for Dawei to ensure sustainable tourism development with community participation.

Acknowledgement

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INTERNATIONAL TOURISTS PERCEPTION AND SATISFACTION ON YANGON DESTINATION AREA

Win Pa PaMyo[1],Myo Myo Khine[2] and Khin Khin Soe[3]

Abstract

This paper attempts to investigate the antecedents of international tourist satisfaction. The focus of the study is Yangon Area, a well- known tourist destination in Myanmar. It tries to present international tourist perception on Yangon area from the geographical point of view. The study area has many attraction sites such as cultural and heritage attraction sites. This area is extremely easy to reach with several modes of transportation. The main objectives of this study area are to assess on international tourist arrival, to evaluate the international tourist perception and satisfaction on attraction sites and to predict future prospect on international tourist attraction sites. The research uses both quantitative and qualitative methods. Questionnaires are distributed to foreign tourists of the study area. Only 250 questionnaires were distributed to international tourists. Primary data is conducted by interviews and discussions with international tourists. Secondary data are also applied in this research; these data are obtained from Ministry of Hotel and Tourism Departments. The findings of this study could provide guidelines for tourism development and destination operators to further develop better strategies to satisfy travellers to Yangon.

Keywords: international tourist, tourist attraction sites and tourist perception

Introduction

Yangon Region is industrially and commercially the most developed region among the States and Regions of the Republic of the Union of Myanmar. Yangon is a region of importance nestled on the south-central part of Myanmar. Yangon was the old capital of Myanmar. It is also the current commercial capital of the country. Yangon is one of the gateways to Myanmar for international tourists. The city houses a large number of colonial-era buildings in Southeast Asia and has a unique colonial-era urban core that has been maintained over the years. Generally, the age of Yangon is over 2500 years. Then, the area have gone through different experiences such as civil state period, town of trade, seaport of Myanmar King period, the capital of British, the capital of independent Myanmar, and the commercial city. Therefore, many diverse colors of religion, ethnic, activity has existed (Phray Reh Linn Naing, 2010). The interesting tourist attraction sites are various in Yangon.

International tourist perception is the assessment of the trip to specific tourist attractions and thus it can somehow support tourism management for further development. The success of the tourism industry is dependent on tourist attraction sites. The perception of international tourist is revealed by the recipe of the attributes of the attractions and visions of the tourists.

The accessibility is improved within the area, thus providing ease of travel to the destinations. Yangon possesses better infrastructure for tourism industry. Yangon is the main entry point of international tourists.

Aim

The main aim is to develop tourism of Yangon area by applying findings of the research paper.

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Objectives

The objectives are:

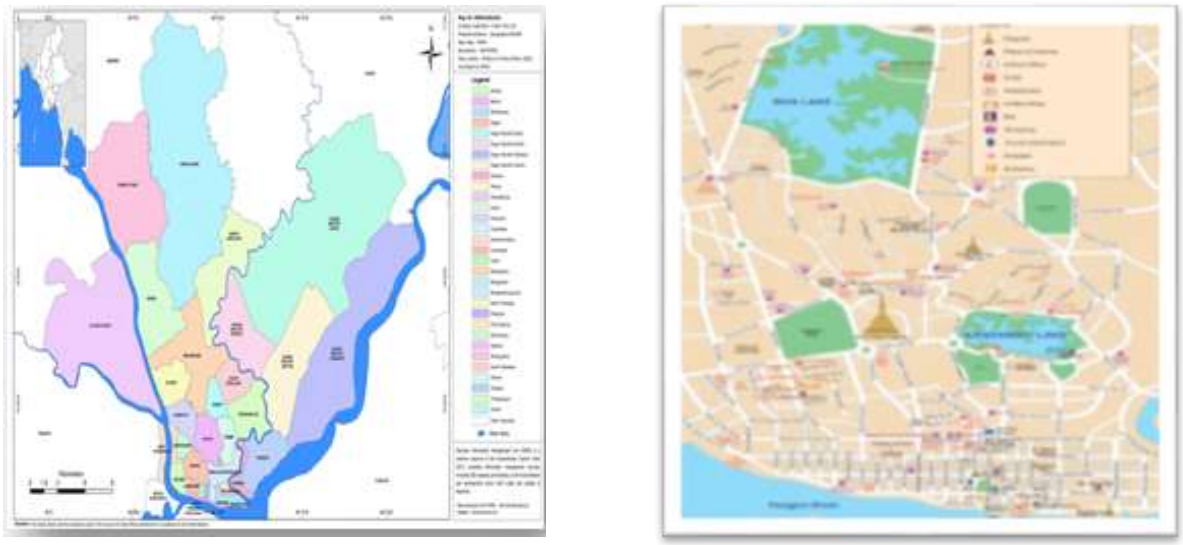
-to assess on international tourist arrival,

- to describe the tourist attraction sites of Yangon Area, and

-to examine the international tourist perception and satisfaction on visiting Yangon

Study Area

This research paper study mainly focuses on tourism of Yangon Area. Yangon Region has an area of 10,170 square kilometers (3,927 square miles). Yangon Region is located between North Latitude 14°and 17°50'and East Longitude 93° 15' and 96° 50'. It is bordered by Bago Region on the north and east, by Gulf of Moattama on the south, and by Ayeyarwaddy Region on the west. Yangon Region is the smallest Region in Myanmar. Yangon City is located in the midst of Yangon Region. Figure 1. Yangon City is included in Yangon Region. It is a former capital city in Myanmar and it is the city of commercial, largest and living place of diverse nationalities of Myanmar. Commercially, Yangon City is the hub of the whole country. The exports and imports mainly pass through Yangon port and Thilawa port. Yangon Region is well-connected with roads, railways, waterway and airway. The area is highly accessible with several mode of transportation.



Source: Myanmar Survey Department

Figure 1 Location of Yangon Region.

Methodology

This research used both qualitative and quantitative approaches. Both primary and secondary data are used for this research. Research methods included observatory, exploratory, questionnaires and interviews with structured and unstructured interviews.

Questionnaire and interview have been conducted in the period from December 2019 to February 2020. Secondary data are collected from the government departments, Ministry of Hotels and Tourism (Nay Pyi Taw and Yangon), journals, theses, newspapers, internet and Google map. The total sample size is 250. The questionnaires and personal interviews are conducted to have different perception of international tourist concerning the overall conditions of the tourism attractions under study.

The data from 250 respondents were analyzed in the study. In the analysis of tourist characteristics, included purpose of travel, length of stay, employment status and demographic data such as gender, age group, occupation, nationality and level of education. Interviews and field surveys are also conducted in this research. The assessment of tourists' satisfaction levels is based on five point- (1) very high satisfaction (2) high satisfaction, (3) medium satisfaction, (4) low satisfaction and (5) very low satisfaction. The facts and data available are tabulated, calculated and presented in diagrams.

Findings

International Tourist Arrivals to Yangon Area

In order to promote the tourism industry in the country and to encourage local and foreign entrepreneurs to take part in the business, the SLORC promulgated the Myanmar Hotels and Tourism Law in October 23, 1993.

On 24th September, 1992, the government formed the Ministry of Hotels and Tourism and licenses were issued to the private entrepreneurs for the registration of hotels and motels which were suitable for the accommodation of foreign tourists. Tourism Department and Management Committee (TDMC) was formed on 27th April, 1994 and the term of visa was extended from 28 days to 70 days. In order to boost the tourism industry, the year 1996 was recognized as Visit Myanmar Year (MOHT, Yangon).

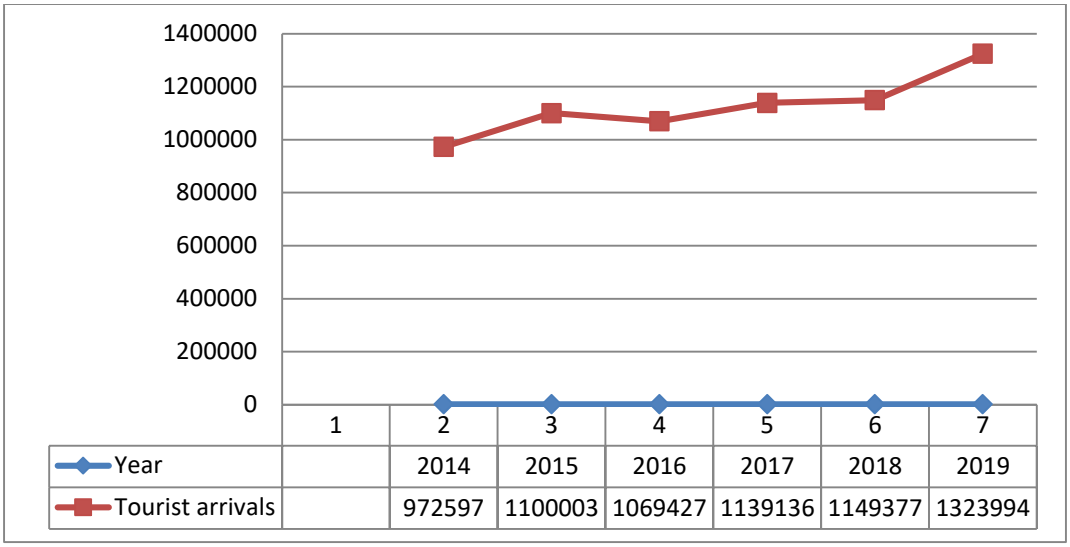
International tourists arrived in Yangon through airport with various visa types such as Foreign Individual Tourist, Group, Business, Social Visit and others.

Table 1 Number of International Tourist Arrivals in Yangon (from 2014 to 2019)

Year	F.I.T (Individual)	Group	EVB (Business)	EV (Social Visit)	Others	Total
2014	311865	156673	186239	45974	271846	972597
2015	274996	141806	170559	49444	463198	1100003
2016	264602	153169	171098	43876	436682	1069427
2017	247308	171169	151951	38116	530585	1139136
2018	229592	184481	218518	29517	487269	1149377
2019	270105	292321	239121	34648	487799	1323994

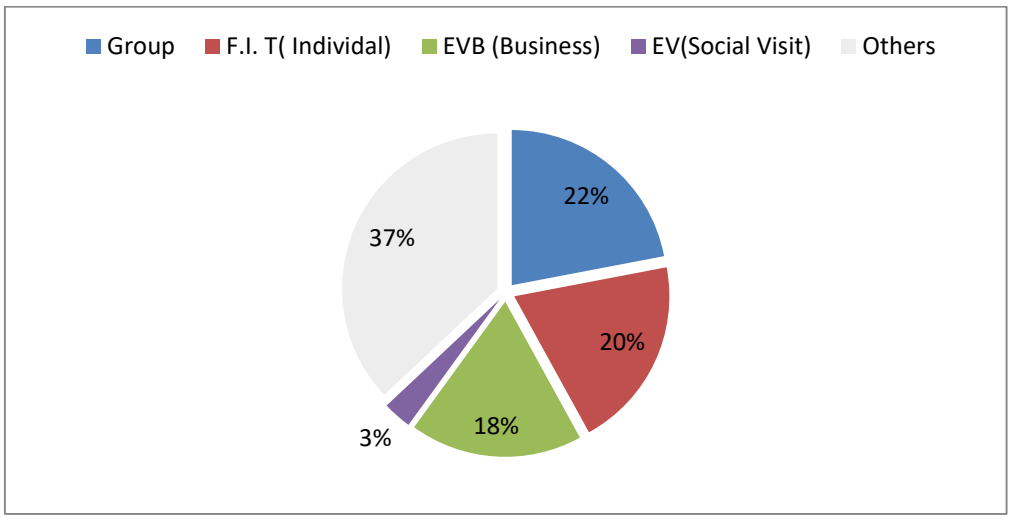
Source: Ministry of Hotels and Tourism, Nay Pyi Taw

According to table 1, the number of international tourist that visited Yangon City was 972,597 in 2014; it increased to 1100003, 1069427, 1139136, 1149377 and 1323994 from 2015 to 2019 respectively. The number of visitors has increased up to two times within 2014 to 2019. According to figure 3, group tours was the highest number with 292,321 (22 percent) in 2019 and the second highest was F. I. T (or) Individual with 270,105 (20 percent). The third highest was EVB or Business with 239,121(18 percent). The lowest number was E.V (Social Visit) with 34,648 (3 percent).



Source: Based on table 1

Figure 2 International Tourist Arrivals in Yangon from 2014 to 2019



Source : Based on Table 1

Figure 3 Percentage of International Tourist Arrival to Yangon in 2019

International Tourist Arrivals by Tourist Generating Regions

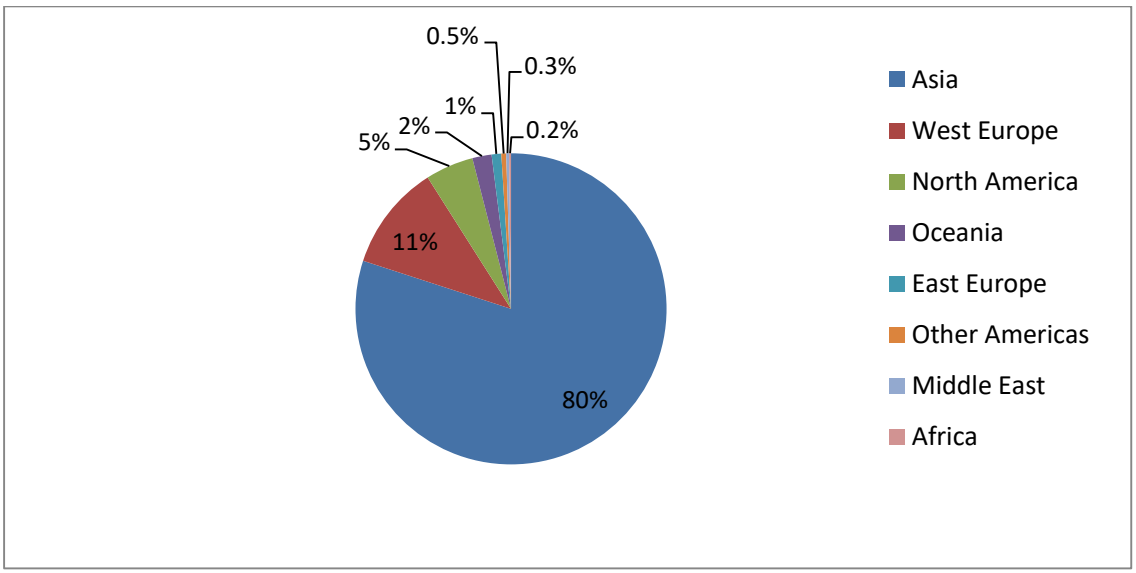
The international tourists visit Yangon Area in 2019, it can be grouped into 8 tourist generating regions and these are Asia, West Europe, North America, Oceania, East Europe, Other Americas, Middle East and Africa. These are shown in Table 2 and Figure 4. Comparatively, the share of tourists from Asia was the largest number with 1,060,396 or 80 percent, followed by West Europe with 142,443 or 11 percent, North America with 65,510 or 5 percent, Oceania was 25,654 or 2 percent and East Europe was 13,538 or 1 percent.

Tourists from other regions have been relatively too small in numbers, only 8036 or 0.5 percent from Other Americas, 4,558 or 0.3 percent from Middle East and 3,859 or 0.2 percent from Africa and respectively. Table 2

Table 2 Number of International Tourist Arrival in Yangon Area by Tourist Generating Region (2019)

No.	Nationalities	Tourist arrival	Percentage to total
1.	Asia	1060396	80
2.	West Europe	142443	11
3.	North America	65510	5
4.	Oceania	25654	2
5.	East Europe	13538	1
6.	Other Americas	8036	0.5
7.	Middle East	4558	0.3
8.	Africa	3859	0.2
Total		1323994	100

Source: Ministry of Hotels and Tourism, (Nay Pyi Taw)



Source: Based on Table 2

Figure 4 Percentage of International Tourist Arrival by Tourists Generating Regions

As shown above, Asian was ranked first in the number of tourists who frequently visited the study area. Among the Asian tourists, China was the largest in numbers, sharing 32 percent of total Asian tourists, followed by Thailand with 22 percent and Japan with 11 percent. The other Asian countries that visited Yangon include Korea, Singapore, Vietnam, India, Malaysia, Taiwan, Hong Kong and Philippine. The number of tourists from Asian countries like China, Korea and Japan has significantly increased. The number of tourists from other countries has slightly increased, but the number of tourists from Thailand has significantly decreased compared to last year (2018). During the period 2014 to 2019, the number of international tourists' arrival was greatest in December and the lowest in June.

Seasonal International Tourist Arrivals

Generally, tourists like to travel in the dry season for recreation or other purposes. The months October, November, December, January, February, March and April and May are the dry season for research area, whereas the rainy months of June, July, August and September are rainy season for the study area. Table .3

In 2019, the research was visited by 1323994 tourists. The season is divided into three seasons, via; normal season, high season and peak season. Normal season is from June to September, and high season is October, February, March, April and May. The peak season is the best time of the year for foreign tourists and it begins from November, December and January. The number of tourists usually increases during Christmas and New Year time. Every year, November and December tops the list in the number of tourists.

Table 3 Seasonal international tourist arrivals by monthly and yearly. (2014 - 2019).

No	Months	2014	2015	2016	2017	2018	2019
1	January	91760	104422	102373	117043	112806	119990
2	February	89167	101113	103638	113785	103632	123990
3	March	89214	97877	94655	102082	107908	118005
4	April	71644	72552	69136	79176	82523	99193
5	May	68659	74787	74702	78096	83894	96047
6	June	60030	67267	66774	72662	75488	87063
7	July	69695	74795	78726	81445	81133	99042
8	August	67701	81705	75365	78493	78425	98249
9	September	69137	84663	75845	79366	77032	94215
10	October	90317	107586	99959	102060	101201	115739
11	November	103589	115864	111702	118611	120257	133339
12	December	101684	117372	116552	116310	125078	139122
	Total	972597	1100003	1069427	1139129	1149377	1323994

Source: Ministry of Hotels and Tourism, (Nay Pyi Taw)

Types of Tourist Attraction Sites in Yangon Area

Tourist attraction sites of study area are based on three sites such as religious sites, recreation sites and architecture buildings. Yangon was an economic hub and former capital of Myanmar for more than 120 years before the administrative capital officially moved to Nay Pyi Taw in 2007. It has rich and diverse heritage buildings. In May 1996, Yangon City Development Committee issued a list of 189 heritage buildings in Yangon. It included religious building such as pagoda, monasteries, churches, mosques, Hindu and Chinese temples, building of administrative and institutional nature, commercial and educational building and ethnic communities. Therefore, there is no doubt that the international tourists take more and more interest in the study area.

(a) Religious Sites

There are many religious tourist attraction sites in the city of Yangon. These religious sites are Shwedagon, Botahtaung, Sule, Kohtatkyi, Chauk Htak Gyi, Maha Wizaya, Kabaaye Pagodas and Nga Htat Gyi Buddha Image. Most of the Christians visit St. Marry's Cathedral and some

Christians visit Judson Church at Yangon University. Islam, Sunni Mosque is at downtown. Chinese, Kheng Hock Keong Temple at Lanmadaw Township. Hindu, Sri Kali near Bogyoke Aung San Market.

(b) Recreation Sites

Yangon area has many recreation sites. These are Kandawgyi Garden, Karaweik Hall, Zoological Garden, The people's square and park, Hlawga National Park, Maha Bandula Park, Htauk Kyant War Cemetery, Bogyoke Aung San Market, National Museum, Myanmar Gems Meuseum, Drug Elimination Museum, Bogyoke Aung San Museum, China Town, Inya Lake and Yangon University and National Race Village.

(c) Architecture Building

Yangon is widely known for having the highest density of colonial period buildings in Southeast Asia. The Yangon City heritage building list consists of religious structures, ancient pagodas and British colonial buildings. The imposing red brick high court, the legendary strand hotel, the sprawling victoria elegance of the secretariat and Yangon City Hall are most visit places.

Assessment on the International Tourist Perception and Satisfaction

The perception and satisfaction of international tourist are based on the existing cultural and natural attraction sites, demographic characteristics of the tourists, their travel behaviours, opinions, and level of satisfaction. Tourist satisfaction is important to successful destination marketing, because it influences the choice of destination, the consumption of products and services, and the likelihood of returning to that destination (Kozak & Rimmington, 2000).

Questionnaires are distributed to international tourists of the study area as well as to those who are moving around the three main attraction sites, to know whether they intend to satisfy site attributes. Questionnaire and interview are conducted to have different perception of tourist concerning the conduction of the international tourist attractions under the study. Demographic data are used for the analysis of tourist characteristics. Demographics data includes gender, age group, occupation and level of education. Table .4

Table 4 Percentage of International Tourists' Characteristics (N=250)

No.	Item	Sub item	No of results	Percentages
1	Gender	Male	172	69
		Female	78	31
2	Age- group	Under 20	36	14
		between 21 and 50 years	175	70
		51 and above	39	16
3	Occupation	Employed	65	26
		Self- employed	98	39
		Retired	30	12
		Students	54	22
		Other	3	1
4	Education	Graduate	149	60
		Post-Graduate	28	11
		Undergraduate	64	26
		Others	9	3

Source: Questionnaires Survey and interviews (2019)

According to table 3, the gender distribution of the respondents was uneven, 69 percent are male and 31 percent are female. The numbers of males exceed females. The average age group of between 21 and 50 is the most dominant consisting of 70 percent. Generally, in occupation, self-employed is highest in percent at 39 %. According to the level of education, the highest are graduated level with 60 percent. Everyone who has been to Yangon visited Shwedagon Pagoda, as the majorities are Buddhists and the highest numbers of international tourists are from China. All international tourists visited the Shwedagon Pagoda; what is the most attractive place for tourists. The second most attractive place is the downtown area of Yangon. International tourists are very interested in colonial buildings such as Churches, temples, rail ways station, offices, resident's houses and markets. The lowest attraction places are museums. This suggest that it requires an updated and need more skill labours (i.e tour guides) to explain about history in museums.

Table 5 Percentage of International Tourists' Travel Behaviour Characteristics (N= 250)

No.	Item	Sub item	No of results	Percentages
1	Frequency of visit to Myanmar	once	128	51
		2 to 3 times	73	29
		4 to 5 times	13	5
		More than 5 times	36	15
2	Length of stay in Yangon	1 to 5 days	130	52
		Over a week	69	28
		Over a month	31	12
		Over a Year	20	8
3	Stay in	Hotel	136	54
		Motel, Inn, Guesthouse	55	22
		Relative House	50	20
		Others	9	4
4	Purpose of Travel	Vacation	135	54
		Business	77	31
		Pilgrimage	13	5
		Others	25	10

Source: Questionnaires Survey and interviews (2019)

International Tourists' arrival according to Frequency of visit to Myanmar, are shown in table 4. 51 percentages of international tourists have never been to Myanmar are first time visitors, whereas the remaining 29 percent have been revisited 2 to 3 times, 5 percent have been 4 to 5 times and 15 percent have been over 5 times.

Length of stay is also an important aspect for tourism, only 52 percent of international tourists spent one to five days in Yangon, it is the highest. With regards to accommodation, the largest numbers of tourist choose hotels, having 54 percent. The purposes of international tourists visiting as a vacation are 54 percent. There are 31 percent of total international tourists going to Yangon for business reasons and 13 percent of respondents visit Yangon for pilgrimage. According to these results, the main purpose is for vacation. Table 5

The questionnaire was structured with satisfaction levels based on five point- (1) very high satisfaction (2) high satisfaction, (3) medium satisfaction, (4) low satisfaction and (5) very low satisfaction.

Table 6 Tourists Satisfaction level in Yangon Area and its Vicinity. (2019)

Satisfaction levels	Frequency	Percentage (%)
Very high satisfaction	53	21
High satisfaction	122	49
Medium satisfaction	42	17
Low satisfaction	23	9
Very low satisfaction	10	4
Total	250	100

Source: Questionnaires Survey and interviews (2019)

As a result, most of the respondents were highly satisfied with 49 percentages. The lowest percentages are very low satisfaction with 4 percent. The perception of international tourist on tourism related supporting factors are mostly positive. The most satisfied are accessibility and accommodation because travellers can directly access by car, rail way, water ways and air way from Yangon to other places. About 80 percent was satisfied with hotel facilities, and services. Among them, the 80 percent were interested in cultural heritage or colonial buildings. There are comfortable accommodation facilities in all tourist destination of the study area that is popular among the international tourists. Only 10 percentages of the respondents were not satisfied with the existing communication facilities due to extremely high rates charged for internet used, and slow Internet connections. To get more satisfaction, the tourism authority and respective tourism operators should control the price, services and well internet connections.

Discussion

Tourist arrivals from Asia are the highest number. Therefore, the development of tourism in the Yangon City largely depends on the tourist generating area of Asian countries. The shares of international tourists from tourist generating regions suggest that, the development of tourism in the Yangon Area depends mainly on pagodas, religious buildings, heritage buildings, architectural style of ancient buildings, historical sites, culture and recreation sites that attract visitors from Asian and European countries.

Visitors from China and Thailand are interested in culture, especially “architecture of pagodas", arts and culture. The Japanese visitors are more concerned with business and partly with culture. The location of Yangon as the commercial city and its beautiful environments attract tourists to visit. Tourists especially, prefer visit at the pagoda. Other tourists from the affluent countries are also attracted by the grandeur of some historical sites. Asians tourists are more satisfied with attributes concerning attractions, accommodation, and activities while European tourists are less satisfied with such attributes. Tourist attractions are indeed the factors supporting the development of tourism (Khin Thandar Oo, 2017).

Conclusion

In Myanmar, many of the tourist attraction sites in Yangon are known for the Tourism industry. Yangon is the gateway for all type of tourist and is a transit point for tourism of Myanmar. In Yangon there are historical sites, religious and colonial building, recreation, museums, national park and cultural events. Most of the international tourists arrive in Yangon and later they visit to other attraction sites of Myanmar. Therefore, Yangon is the focal point for the development of tourism in Myanmar.

The arrival of international tourists in Yangon City varies both spatially and seasonally. Generally, the number of tourists decreases in the rainy season from June to September. Among the hotels, motels and restaurants that can arrange quality European cuisine, the waiters and waitresses should wear Myanmar costume and the quality of restaurants should be upgraded.

Asian countries rank first among the tourist generating areas for Yangon, while Middle East and Africa are listed at the bottom. The variations in the number of tourists from different tourist generating zones reflect the differing preferences, likes and dislikes of different nationalities. Generally, the westerners take interest in local traditional culture and in nature whereas the easterners enjoy viewing urban life styles and religious structures. Some shops located nearby to the Buddha images in certain sites should be moved a little further away. Some sellers sleep in the shops within the pagoda compound and dump food waste near their shops. Such scenes tarnish the image of the pagoda and make unfavorable conditions. There are no interpreters who can explain about museums, historical sites and history of the study area.

International tourist's perception and satisfaction are important for tourism development in Yangon destination area. As tourist satisfaction is high on attraction attributes, monitoring of tourist satisfaction should be implemented and focused on to promote the Myanmar culture and custom, but also encourage people to be aware of proper preservation of the national heritage of the country. The findings suggest that international tourists from various regions have different levels of satisfaction with five levels. The perceptions of international tourist on the famous sites are mostly positive. The tourism potential of Yangon City would remain high in the future, because of its excellent beauty scene, ancient cultural, trait and religious structures.

Acknowledgement

First, we would like to thank to Dr. Myo Myo Khine (Professor and Head of Geography Department), for her permission to carry out this project. We wish to record thank to Dr. Maung Maung Nyunt (Professor, Geography Department) and all the staff in our university who in diverse ways contributed to our research.

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RAIL TRANSPORT POTENTIAL FOR UNIVERSITIES STUDENTS IN THANLYIN TOWNSHIP

Nyein Nyein Win[1], Let Let Myat[2], Khin Saw Myint[3], Win Thet Myint[4], Tin Tin Khine[5], Kyaw Swar Lyinn[6]

Abstract

This paper focuses mainly on the use of train by the students attending the universities in Thanlyin Township. The increased use of train can result in the decreasing use of buses (car) by the students, leading to the number of buses between Thanlyin and Yangon City. This will reduce the traffic jam over Yangon–Thanlyin Bridge. This paper identifies the perception of the students on rail transport, the current rail service on this particular segment and the degree of competition between different modes of transportation, particularly between bus service and rail transport service.

Keywords: rail services, traffic jam, students' perception, Yangon-Thanlyin Bridge

Introduction

Thanlyin Township is one of the townships in south district of Yangon Region and also included in Yangon City. It is located between north latitude 16˚ 40′and16˚ 59′east longitude 96 ˚ 17′and 96 ˚ 25′. Bago River is in the north, Khayan Township and Thongwa Township in the east, Kyauktan Township in the south and Yangon River in the west.

Three bridges across the Bago River connect Thanlyin with other townships of Yangon City. Yangon-Thanlyin Railroad Bride, Yangon-Thanlyin Bridge No (1) with two Car-roads (one for going and another for return trips) and railroad along the middle between the two car-roads [plate 1] connects Thanlyin with Thakayta Township, opened at 31st July 1993[Tin Tin Khine., 2020]. The existing Yangon-Thanlyin Bridge No (1) is one way tract. It is the main entrance to CBD of Yangon City by the people of Kyauktan, Khayan, Thonekhwa, in addition to Thanlyin.

Another bride called Kalaewe (Dagon), open at 2007 [Tin Tin Khine., 2020], can be used for the movement between Thanlyin and Dagon Myothit (East). Kalaewe (Dagon) Bridge is a six ways tract and no YBS bus runs across the bridge. As it is connected with urban fringe (Dagon Myothit (East)), there is no traffic conjunction on this bridge.

Bago Bridge (Thanlyin 3) is being built simultaneously with Yangon-Thanlyin Railroad Bridge at 125 meters downstream. At present (July, 2020) 41 percent has been completed and it will be finished and opened in 2023. [http://www.newswatch-nw.com/, 2020]

This indicates that there is only entrance to Thanlyin by rail transport, but two entrances by motor vehicles transport. However, there are seven bus lines (Yangon –Thanlyin and Yangon-Kyauktan/ Thonekhwa –Khayan) currently serving across the bridge, Yangon-Thanlyin Bridge No (1), while traffic jam is not uncommon on that Yangon-Thanlyin Bridge especially in the rush hours. The problem of traffic congestion over the bridge is getting worse.

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Students of Universities in Thanlyin

Thanlyin Township currently (2020) has four Universities and these are: (1) East Yangon University, (2) Cooperative University, (3) Myanmar Maritime University and (4) Government Technology University (Thanlyin). These universities are located on either side of Kyaikkhaut Pogoda-Kyauktan road. Although the location of Students of the four universities are not the same, about 50 percent of the students are living in the areas (north of the Bago River) that can use rail transport and the remaining 50 percent cannot use the train to get to their respective universities as they are residing in Kyauktan, Thongwa and Khayan townships [Table 1].

Table 1 Students Distribution of Universities in Thanlyin (2019-2020 Academic Year)

	University	Townships																				Total
		Kyimyintine	Alone	Sanchaung	Lanmadaw	Latha	Pabaedan	Kyauktada	Botahtaung	Pazundaung	Mingalartaun	Thakeyta	Dawbon	Dala	Seikkyikhana ungto	Thonekha	Kyauktan	Khayan	Thanlyin	Seikkan	Others	
																					A* B**	
Numbers of Students	EYU	443	201	281	88	34	67	89	238	218	422	1944	597	767	194	1155	930	797	2191	14	210 1144	1202
	GT	14	17	26	24	16	17	38	49	72	142	224	45	25	3	26	71	32	190		519 1052	2682
	MMU	The Whole Myanmar																				2010
	TCU	The Whole Myanmar																				1686

Source: Faculty Departments, Universities in Thanlyin, 2019-2020 academic year

A* = The Townships, that near Stations (South Dagon, North Dagon and Thingangyun)

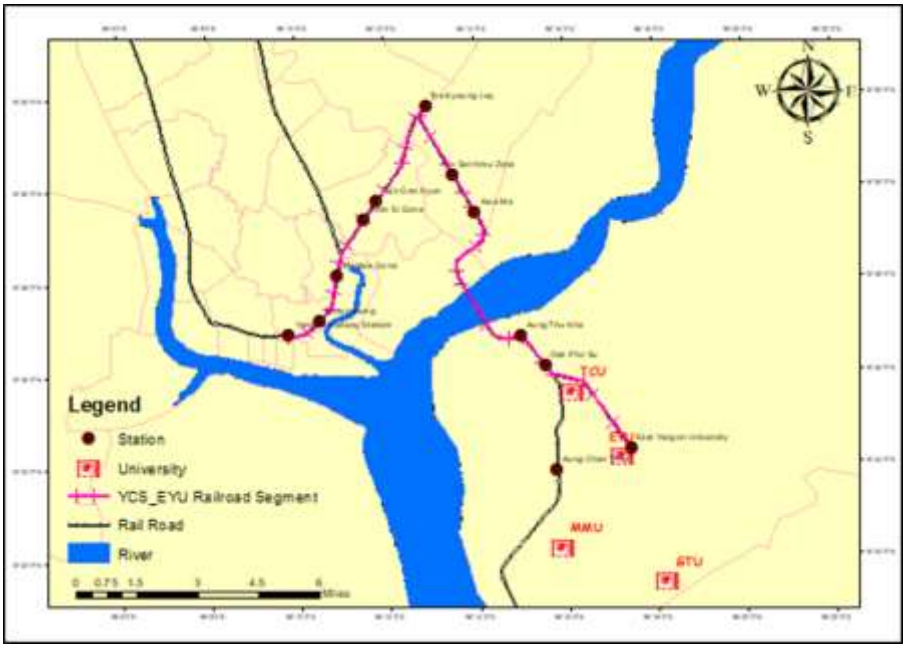
B** = Except from A

*** (1) East Yangon University (EYU) = Yangon Area,
(2) Cooperative University (TCU) = the whole Myanmar
(3) Myanmar Maritime University (MMU) = the whole Myanmar
(4) Government Technology University (GTU) = the whole Myanmar

Plate 1 Yangon-Thanlyin Railroad Bride,

Source: Photograph has taken in February, 2020

Note: Yangon-Thanlyin Bridge No (1) with two Car-roads (one for going and another for return trips) and railroad along the middle between the two car-roads, and construction site for Bago Bridge (Thanlyin 3)



Source: Based on UTM map, Cartographer is Daw Win Thet Myint , 2020

Figure 1 The Pattern of Yangon Central Railway Station-East Yangon University Railroad Segment and Distribution of Universities in Thanlyin

Rail Segment Service System

This rail segment of Yangon Central Railway Station-East Yangon University was opened on 1.6.2006, kilometers 32.2 km (20 miles) long, having 12 stations on the way. These stations are Yangon Central Station, Puzundaung, Malwagone, Hninsigone, Thingangyun, Ngamoeyeik, Toegyaunggale, Industrial Zone 1, Kawema, Aungthukha, Oakphosu, Thama (Nyaungthonbin) and East Yango University. There are 4 railway stations in Thanlyin Township and these are Aungthukha, Okphosu, Thama or Nyaungthonpin or Cooperative University and East Yangon University. The distribution of railway stations and universities are presented in figure 1 and Locomotive and Suburban (Thanlyin) Railroad Pattern in figure 3.

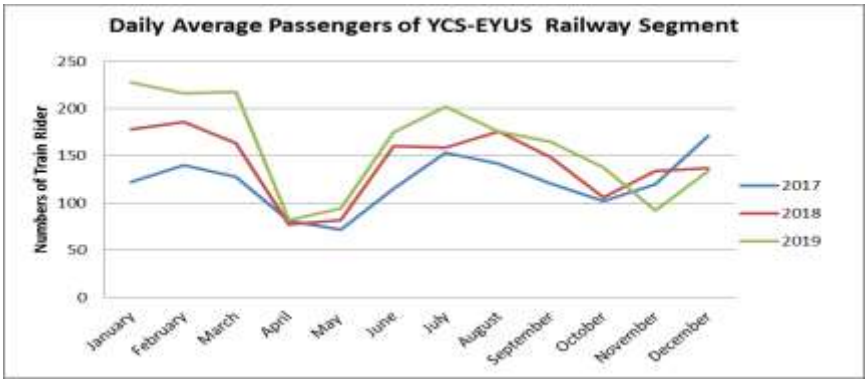
The rail service is auto system between Yangon Central Station and Toegyaunggale and the segment between Toegyaunggale and East Yangon University is "Absolute Block System". It takes time at Toegyaunggale station because it needs to turn the locomotive there. It usually takes about 15 minutes. The train also has to wait for some time if there is freight train or Yangon-Mandalay train moving across the station. As Toegyaunggale station is located at the most popular part of Dagon north-south road junction; it takes about 15 minutes to get across the rail and road junction. And then, Thama or Nyaungthonbin or Cooperative University has no real railway station.The train stops for a few minutes by the sign of carriage control system.

Rail transport serves 5 up and down trips daily (see table 3 & 4). The speed limit is 15 miles per hour. It takes about two hours (one hour and 55 minutes) to get to East Yangon University from the Yangon Central Station. The charge rate is Ks 100 for 15 miles. The monthly charge rate for an ordinary traveller is Ks 3150, but special rate has been practiced for the student with Ks 2250. Daily average numbers of passengers of this Railway Segment is shown by table 2.

Table 2 Daily Average Passengers of YCS_EYUS Railway Segment

Months / Year	January	February	March	April	May	June	July	August	September	October	November	December
2017	110	124	116	75	70	107	115	116	113	96	116	149
2018	150	148	147	69	76	138	129	144	129	96	126	117
2019	198	186	196	76	88	167	146	142	147	128	84	112

Source: Manager, Yangon Region, Myanmar Railway Service, June, 2020



Source: Based on Table 2

Figure 2 Daily Average Numbers of Passengers of YCS_EYUS Railway Segment

Table 3 Railway Trip Schedule from Central Station to East Yangon University Station

No.	Station	Ba-2	Nya-1	Da-4	Ma-7	Da-6
1	Central Station	06:05	06:55	09:40	13:05	13:50
2	Puzundaung	06:13/06:14	07:03/07:04	09:48/09:49	13:13/13:14	13:58/13:59
3	Mahlwagone	06:22/06:23	07:12/07:13	09:57/09:58	13:22/13:23	14:07/14:08
4	Hninsigone	06:28/06:29	07:18/07:19	10:03/10:04	13:28/13:29	14:13/14:14
5	Thingangyun	06:32/06:33	07:22/07:23	10:07/10:08	13:32/13:33	14:17/14:18
6	Ngamoeyeik	06:38/06:39	07:28/07:29	10:13/10:14	13:38/13:39	14:23/14:24
7	Toegyaunggale	06:45/06:55	07:35/07:50	10:20/10:35	13:45/14:00	14:30/14:45
8	Industrial Zone.1	07:07/07:08	08:02/08:03	10:47/10:48	14:12/14:13	14:57/14:58
9	Kawayma	07:13/07:14	08:08/08;09	10:53/10:54	14:18/14:19	15:03/15:04
10	Aungthukha	07:31/07:32	08:26/08:27	11:11/11:12	14:36/14:37	15:21/15:22
11	Oakphosu	07:39/07:40	08:34/08:35	11:19/11:20	14:44/14:45	15:30/15:40
*	Thama					
12	East Yangon University	07:55	08:50	11:35	15:00	15:55

Source: East Yangon University Station (March 2020)

Table 4 Railway Trips Schedule from East Yangon University Station to Central Station

No.	Station	Ba-3	Nya-2	Ma-8	Da-7
1	East Yangon University	08:15	09:20	15:20	16:05
*	Thama				
2	Oakphosu	08:30/08:40	09:35/09:36	15:35/15:36	16:20/16:21
3	Aungthukha	08:47/08:48	09:43/09:44	15:4315:44	16:20/16:21
4	Kwaema	09:05/09:06	10:01/10:02	16:01/16:02	16:46/16:47
5	Industrial Zone.1	09:11/09:12	10:07/10:08	16:07/16:08	16:52/16:53
6	Toegyaunggale	09:25/09:45	10:20/10:30	16:20/16:30	17:05/17:15
7	Ngamoeyeik	09:51/09:52	10:36/10:37	16:36/16:37	17:21/17:22
8	Thingangyun	09:57/09:58	10:42/10:43	16:42/16:43	17:27/17:28
9	Hninsigone	10:01/10:02	10:46/10:47	16:46/16:47	17:31/17:32
10	Mahlwagone	10:07/10:08	10:52/10:53	16:52/16:53	17:37/17:38
11	Puzundaung	10:16/10:17	11:01/11:02	17:01/17:02	17:46/17:47
12	Central Station	10:25	11:10	17:10	17:55

Source: East Yangon University Station (March 2020)

Source: Photograph taken by Daw Let Let Myat, February 2020

Plates 2. Students are waiting train for go back home at East Yangon University Station

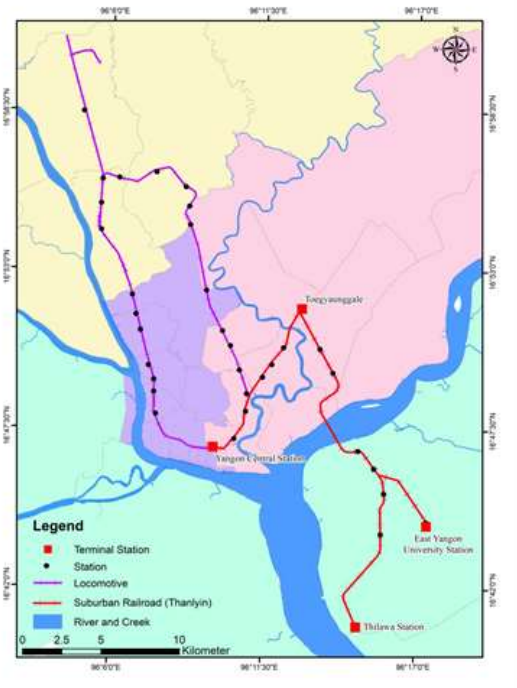
Source: Photograph taken by Daw Let Let Myat, February 2020

Plates 3 Relaxed, Comfort and Safe Train Riders on Train

Other Mode of Transport Service System

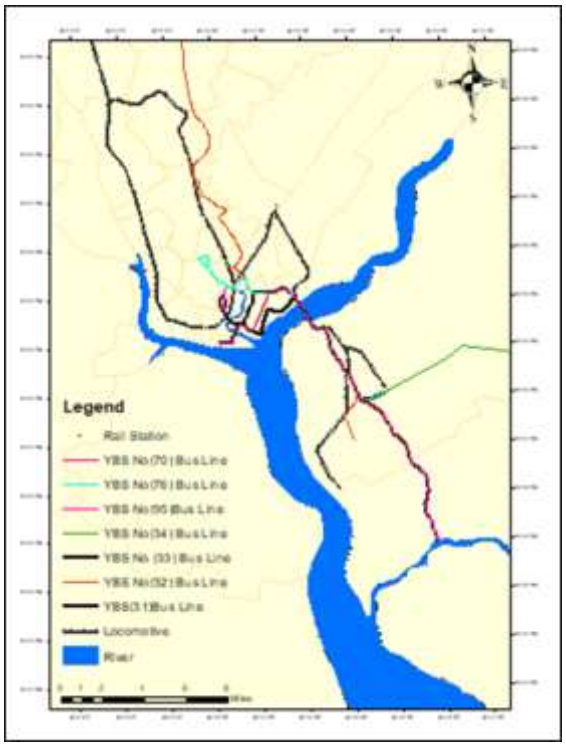
There are 7 buslines serving between Thanlyin and Yangon. The students can get directly to East Yangon University by using YBS No.31, 34, 76 buslines. The students can change to YBS No.33, 70 and 95 at Phayargone bus-stop. There are three YBS bus lines to get directly to Government Technological University, while only YBS No.32 can be used to get directly to

Myanmar Maritimes University. Cooperative University is accessible by all seven bus lines, but the students have to change from the bus-stop to Cooperative University by other hire vehicles. Figure 4 shows the routes of bus lines. There are "Private ferry Services" run between students home town and universities.



Source: UTM map, MIMU, 2020

Figure 3 Locomotive and Suburban (Thanlyin) Railroad Pattern



Source: YBS Busline.com

Figure 4 Railroad and Seven Bus Lines Pattern in Thanlyin

Research Questions

1. Do the university students desire to use rail transport to attending their universities?
2. Is the rail service attractive to these students?
3. What are the competitive conditions of rail transport with other modes of transport?

Aim

This paper intends to provide practicable suggestion for the important of rail transportations in Thanlyin Township. This will lead to the reduction of traffic congestion and smooth flow of the commuters. It depends on the rail service and the use of train by the students in attending their respective universities. This research work focuses on rail transport potential for the students of universities in Thanlyin Township.

The objectives are: to understand the advantages and disadvantages of using rail transport in compare with other mode of transports and to examine the perspectives of university students on using rail transport in their daily commuting.

Materials and Method

In acquiring primary data related to rail service along the Yangon Central Station-East Yangon University segment, field observation, open talk and interviews are conducted with the station master of East Yangon University Station, Kawema Station and Toegyaunggale Station.

To know the perception of the students on rail transport, a total of 400 questionnaires, 150 questionnaires are distributed to those who usually take the train, 200 questionnaires to non-train rider students of East Yangon University, including those who take bus lines, motorcycle carriers, and ferry) and 50 questionnaires to Thanlyin Cooperative University.

Buffer Analysis is used to reveal this different distances from the station with and interval of 5-minute walk-distance (https://www.healthline.com, 2021), including three circles, the innermost circle for 5 minutes, the middle circle for 10 minutes and the outer circle for 15 minutes, of which the area between the 5 minutes circle is the best to get to the nearest station and the area outside the 15 minutes circle may take a long time to get to the station.

In acquiring information related to the competition of other modes of transportation, the bus line service between Thanlyin and Yangon as well as private ferry services, taxi and cycle-carrier services are studied, in addition to literature survey. Comparative analysis is conducted on time distance, energy distance and cost distance among the different modes of transportation.

The analysis is essentially based on the data related to the students of EYU, as they are the main riders of the train.

Findings and Discussions

User-friendliness

According to field observation, rail road pattern and distribution of railway stations in Thanlyin Township, if the students of Myanmar Maritime University and Government Technology University want to take the train service, they have to change to bus service at Aungthuka Station. Not only there is no railway station near Cooperative University and the students have to take the train at Nyaungthonpin but also Thama or Nyaungthonbin or Cooperative University has no real railway station. The train stops for a few minutes by the sign of carriage control system. In addition, the path that connects with Nyaungthonbin station and road in Cooperative University (Thanlyin) is very poor condition for use especially in rainy season. East Yangon University is the most easily accessible by train. Hence the majority of train riders are the students of East Yangon University. According to field observation, 2 or 3 students take the trains to get to Myanmar Maritime University and 4 Students to Government Technological University.

In north of Bago River, the locations of stations are not at the same places where the students are residing. The students have to attend the university close to the address (place of home) mentioned in the matriculation examination form. Others include: (1) those who have change the census paper, university change, (2) those who take the subject not being taught in East Yangon University (e.g Library Study) and (3) those whose parent have been transferred from other place.

According to four-class Buffer Analysis, there are only a few students within 5 minute circle and great majorities are living outside 15 minute circle. The students have to spend the time not only between the home and station, but it takes about 5 to 10 minutes to get on the train, after reaching the station. There are only one to four students, who get on the train from every12 stations.

Rail service it taken about 2 hours (one hours and 55 minutes) by train to get to East Yangon University. To reach the university at 9:00 am one must take the train which leaves Yangon Central station at 6.55 pm. To get in time before the train leaves the station one must leave one's home at

5.30 am. Classes are finished at 2:30 pm, but this train leaves East Yangon University station at 3:20 pm and one reaches Yangon Central Station at 5:20 pm and gets back home at 6:00 pm.

Based on the responses to the questionnaires, there are more or less students, who get on the train from all 12 stations of which 68.42 percent get on this train from Kawema Station, table 5 According to open talk interview, 80 to 100 students take the train at Kawema station. Most students take the train at Kawema Station, mostly living in Ward No. 22 of Dagon Myothit (south). The students of this ward are not coinciding to attend EYU but they are enlisted in 'other' townships.

According to bus line pattern and distribution of bus stops, road network and bus services are effective in the area north of the Bago River. All the 7 bus lines enter Thanlyin from different routes, providing chance for the students to take buses. The students can get different bus lines. If one bus breaks down on the way the students can change another bus. They can also take taxi. And the bus-gate releases each bus at every 10 minute interval and 7 buses reach Thanlyin Township in every 10 minutes. Thus the students can take the bus almost at any time.

Although the students have to pay the highest cost for "Private ferry Services"; 30,000 Kyats per month to 40,000 Kyats per month per capita, it is less time consumption, comfortable and more safe than the buses.

The perception of the students

The reasons for those who like to take the train are because of more comfortable and less dangerous. Taking the bus is less comfortable and more dangerous because of competition between the buses on the same route to get more commuters, road damage, traffic jam, dizziness or vomiting due to the movement of the bus and crowded traveler (plates 2 and 3). There is also the danger of pick-pocketed and sexual abuse, being ease on the way, easiness to guess the arriving and moving times of the train, less congestion, having seat, being able to take freely on the train, receiving fresh air from outside, seeing the natural and man-made surrounding clearly, good for health, no road congestion, feeling secure on the train, proximate to the station, being able to attend the class on time and costing only Ks 100 per day.

According to responses to the questionnaires, 88.6 percent of the students taking the trains like to ride it and 54.59 percent of these respondents, including train riders and non-train riders, like to take the train. The responses also reveal that 55 percent that do not go to the universities by train also like to take the train. Among the non-train riders 45 percent dislike to take the train and 45.41 percent of these respondents, including train riders and non-train riders, dislike taking the train, see table 5 and 6.

The reasons for those dislike to take the train are irregularity of the arrival of the train, taking more time in transit, long time interval between one and the next train, the late arrival of the train, difficulty to get to the destination if there is engine problem on the way, less resistance of the carriages, and being distant from the station. Some students from Cooperative University said that it is dangerous for the students in getting on and off the train because of hand sign showing by the staff of the station without caring the movement of the travellers.

Among the 400 questionnaires, 79 responses are received from those who usually take train, 100 from those who do not take the train and 50 from Thanlyin Cooperative University. 104 responses questionnaires dislike taking the train in going to their respective universities in Thanlyin. The reaming 171 questionnaires have no responses and this group can be considered those who do not interesting taking the train, which accounted for 42.75percent. Therefore, it can be concluded that 275 of 400 (68.75%) questionnaires dislike and do not interesting taking the train in going to their respective universities in Thanlyin.

Table 5 Respondents and their Opinion for Taking Railway by Respective Stations

Starting Point (Terminal)	Central Station	Puzundaung	Mahlwagone	Hninsigone	Thingangyun	Ngamoeyeik	Toegyaunggale	Industrial Zone.1	Kaweyma	Aungthukha	Oakphosu	Thama (Nyaungthonpin)	East Yangon University	Total	%
Number of Questionnaires	1	4	7	5	2	-	3	-	52	1	2	-	-	79	
Like	0	4	6	5	2	-	3	-	45	1	2	-	-	70	88.6
Dislike	1	0	1	0	0	-	0	-	7	0	0	-	-	8	11.4

Source: Questionnaire Survey, December, 2019- February, 2020

Table 4 Questionnaire analysis of Rail Transport Potential for Students of Universities

No	Students	Total Numbers of Questionnaire	Respondents		Non respondents		Like		Dislike	
			No.	%	No.	%	No.	%	No.	%
1	Train Rider	150	79	52.67	71	47.33	70	88.6	9	11.4
2	Non- Train Rider	200	100	50	100	50	55	55	45	45
3	Cooperative university	50	50	100	-	-	-	-	50	100
	Total	400	229	57.25	171	42.75	125	54.59	104	45.41

Source: Questionnaire Survey, December, 2019- February, 2020

Conclusion

According to the responses to the questionnaires the decision on the choice of vehicle service by the university students depend on: (1) time in transits, (2) being comfortable and free from accident, and (3) low cost. However, there is no mode of transport that can satisfy all the three requirements. Based on the user demand, the existing mode of transport can be categorized into three classes. 'Class A' is characterized by moderate time span in transit, but comfortable and uncertain as regard to accident and the cost is low; bus services. 'Class B' is speedy and takes little time and it is comfortable and has no danger of accident, but the cost is high; private ferry services. 'Class C' takes the longest time in transit, but it is comfortable, free from the danger of accident and low in cost; rail service. As a result, the numbers of universities students who take train is rather small.

There are three main reasons for why university students do not take the train. First reason is that the locations of stations are not at the same places where the students are residing, second, it takes more time to get to the destination by train and third is the advantages conditions of bus lines road network.

These factors can be seen clear in for instance of university students in No.22 of Dagon Myothit (South), the daily number of students that take train at Kawema Station is 80 to 100. They live in Ward No.22 of Dagon Myothit (South) Township; near to the Kawema Station (within 10 minute buffer cycle). As the train usually leaves Kawema station at 8:08-8:10 am, the students need not leave their home early. From Kawema station it takes about an hour to get to East Yangon

University. It costs only Ks 100 daily and Ks 2250 per month. Rail service in suitable for these students; no time in transits, being comfortable and free from danger (accident), and low cost. If they take the buses, the two steps bus fare for getting the university is Ks 500 and another Ks 500 for the return trip, costing Ks 1000 daily. If the students take ferry, it will cost Ks 1500 daily. If the class is finished at 2:30 pm, the students will get home at 3:00 pm and they can save time. Therefore, using train for those students in Ward No.22 of Dagon Myothit (South) is in 'Class A'.

Although 88.6 percent of the students taking the trains and 55 percent of non-train riders like to take the train, the daily number of students that go by train to the university is very small. The daily number of students taking the train is 168 to 198 which account for only 1.08 percent of the total students of 4 universities.

The effectiveness of rail service on the university students of Thanlyin Township is very limited. The number of students that use train has been declining. Therefore, the rail service related to university students has no effect on the traffic congestion over Thanlyin Bridge.

According to field observations, there are not only university students but also a few local resident passengers in Thanlyin use rail transport. Although it expenses less to use the train, long commuting time on the way limit the local resident passengers to use rail. To reduce the time it is necessary to upgrade the locomotives, the bridges on the way and transport system. It may cost a large sum of expense. As the number of travelers is small on this rail segment, the authority concerned has no budget to upgrade. Myanmar Railway Enterprise is supported by the government. The condition of rail transport depends on the budget. The weakness of rail transport is slow speed, long transit time and small number of passengers, resulting in low income. This result of low income restricts the upgrading of rail facilities.

Two suggestions are given for better use of rail in daily commuting of students. The first one is to speed up the movement of the train to reduce the travelling time from 2 hours to one and a half hours to be able to compete with bus service. The speed of the train is needed to be raised from 15 miles per hour to 20 miles per hour. By doing so, the rail transport will become speedy, comfortable, free from danger with comparatively low cost. If the train takes less time to get to the destination, more students from Pazundaung and Mingalartaungnyint townships likely to take the train. And local resident passengers' choice to rail will be increased.

Another recommendation is to extend the railroad segment from East Yangon University Station to No (6) high way road which is about merely (190 m) in length. By such extension, the commuters from Tarwa village and villages around it can easily get to the CBD of Yangon City. In addition No (6) highway road is the main transportation route connecting Thongwa, Khayan townships. The villagers in the hinterland of these townships can also take the train from that 'node'. Furthermore, that node is proximate to another node that is junction of Thanlyin-Kyauktan road and No (6) highway road. The villagers in the hinterland of Kyauktan townships can also take the train through that 'node'. The location of Government Technology University (Thanlyin) and Myanmar Maritime University become closer to the node. If there is bus service between node and MMU and GTU, the students of MMU and GTU can easily get to this respective university. Likewise, wage earners and low-income family can take the train with low cost.

Fortunately, Toegyaunggale-East Yangon University rail segment is the branches line of Toegyaunggale-Thilawa railroad. It is learnt that Oakphosu-Thilawa section is to be upgraded soon. After the upgrading, the condition of railroad up to Oakphosu Station would be smooth and safer to accelerate the speed of the train.

The extension of railroad to No.6 highway main road and upgrading of the railroad segment between Oakphosu and East Yangon University Station may cost a fairly substantial amount of money (budget). Myanmar rail enterprise is under the control and support of the government. If

the budget allotment is not available or not enough to implement the tasks, it can still try for fund from such intervening opportunities as local authority, chronicles or foreign aid or contribution of certain INGO.

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THE STUDY OF KHITTAYAR MYOTHIT HIGHWAY BUS TERMINAL IN PYAY CITY: CASE OF PASSENGER TRANSPORTATION

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Abstract

This paper examines the study of highway passenger bus transportation in Pyay City in which functional structure of passenger bus transport is also presented. In the study period, not only number of bus gates but number of buses increased. Highway passenger bus transport is analyzed by comparing the development of passenger flow pattern of 1991 and 2020. The high way gate becomes congested due to increase in number of passenger bus gates and passenger buses, and small area of high way gate. In 1991, the total passenger bus gates were 48 bus gates and increased to 65 bus gates in 2020. Objectives of the paper are to present the geographical background of the study area, to express the functions of highway passenger bus transport, to evaluate the development of passenger transportation in Khittayar Myothit Highway Buses Terminal, and to analyze the case on travel-time reduced due to upgraded roads and better passenger bus of Khittayar Myothit Highway Buses Terminal. The primary data collection methodology is interviews and field surveys. Secondary data were collected from department concerned, and GIS tools are applied.

Keywords: highway passenger, bus transport, bus gates, transport services, travel time

Introduction

Passenger transportation, also called public transportation, includes the conveyance of people from one destination to another via avenue, air, or water travel (Taaffe, 1996). The rapid flow of passengers and commodities, the spread of new innovation and ideas and interaction between places including the rural and urban area depend on the effective transportation services (Rodrigue, 2006).

With increasing number of population, construction of new roads and bridges and the number of highway and intra-urban bus lines have been increasing notably after practicing market oriented economic system (Zaw Latt Tun, 2004).

Pyay City is the second largest City in Bago Region. Pyay was also an exchanged center between Upper and Lower Myanmar as well as Rakhine State. It is well connected with other parts of Myanmar by Motor Roads, Rail Roads and Waterway. No.2 Yangon-Mandalay Highway runs across the Bago Region (West) from north to south. To be able to control systematically the movement of the passenger bus lines, the PCDC (Pyay City Development Committee) has established at Khittayar Myothit.

The research work on "The study of Khittayar Myothit Highway Bus Terminal in Pyay City: Case of Passenger Transportation" was conducted to present choice of the place as a transport services. The paper stresses the development of passenger bus lines within Khittayar Myothit Bus Terminal from geographical point of view. The paper does not present bus lines terminated near Myoma Market connecting Pyay City with nearby towns and passenger bus lines crossing Nawaday Bridge and running between Yangon and Rakhine State as these bus lines do not use Khittayar Myothit Bus Terminal.

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Aim

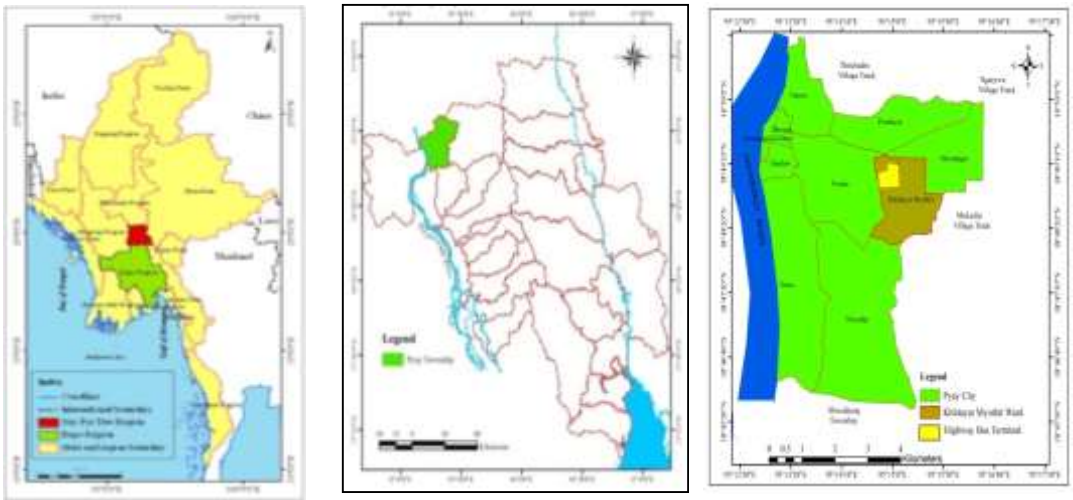
To investigate the passenger transportation of Khittayar Myothit Highway Buses Terminal in Pyay City.

Objectives

- To present the geographical background of the study area,
- To express the functions of highway passenger bus services in Pyay,
- To evaluate the development of passenger transportation in Khittayar Myothit Highway Buses Terminal,
- To analyze the case on travel-time reduced due to upgraded roads and better passenger bus of Khittayar Myothit Highway Buses Terminal.

Study Area

In Pyay City, highway passenger bus transportation is located in Khittayar Myothit Highway Passenger Bus Terminal. Population of Pyay City was 116,418 persons in 2020 and the growth of urban functions and economic condition is one of the factors supporting passenger transportation of Khittayar Myothit Highway Passenger Bus Terminal. The main focus is the functional structure of the terminal including the trend of passenger bus lines.



Source: Land Record Department, Pyay

Figure 1 Location of Khittayar Myothit Highway Bus Terminal in Pyay City

Data and Methodology

Field survey and interviews were done twice in July and August, 2020. During first-time filed survey, data on number of bus line and buses, number of bus gates, passenger carrying capacity of buses of Khittayar Myothit Highway Bus Terminal, constructed period and its development and location map of Khittayar Myothit Highway Bus Terminal were collected from Bus Control Committee. In second field survey period, types of passenger buses, number of passengers per trip, changing pattern of trip reducing time of the trips before and after Nawaday Bridge construction, plans for future development, factors affecting growth of passenger bus lines and types of buses were surveyed at each gate. To compare 2 periods (1991 and 2020), 20 interviews were done with authorities, bus drivers, etc.

Based on the data and information, analysis was made by using statistical methods. To present the paper, two periods (1991 and 2020) were compared.

Results and Findings

Functional Structure of Highway Passenger Bus Services

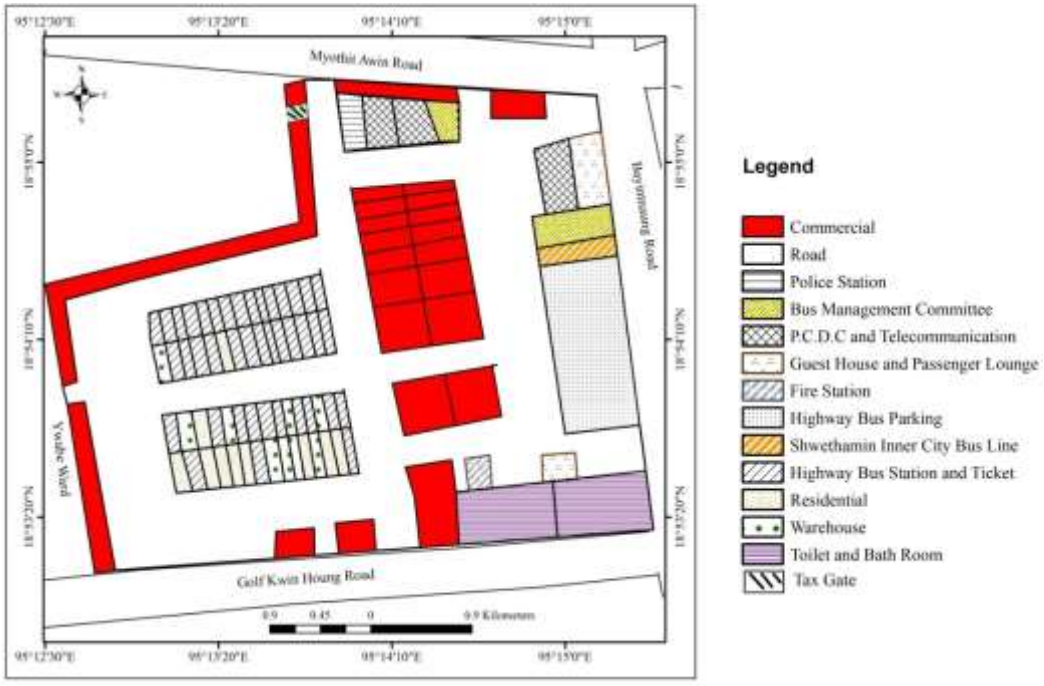
Background History

There are various modes of public transportation in Pyay City but the most important mode is road transport.

Before 1991, buses of highway bus line stopped at different points, particularly in the downtown area of Pyay City including Sitke Road, Babetan Road and Yone Road etc. The unsystematic scattering of highway bus terminals caused the block of road, deteriorating of road, increasing the number of road side sellers, and accidents. Moreover, it is one of the problems for the passengers where they started their journey. There were all together 61 bus lines including 39 bus lines for long-trip, 12 bus lines for short-trip and 10 bus lines for freight transportation. To reduce the problems encountered by passengers, Khittayar Myothit Highway terminal was constructed in 1991 and all high way gates were moved to there (Kyi, 1995). In 2020, there are 65 bus lines running between Pyay and other States and Regions.

The Khittayar Myothit Highway Passenger Bus Terminal is located in the corner of Myothit Awin Road and Bayintnaung Road. It is located in Khittayar Myothit Ward of Pyay City. Latitudinally it lies between 18° 49′ 10″ N and 18° 48′ 50″ N and longitudinally between 95° 14′ 25″ E and 95° 15′ 30″ E. It is bounded by Myothit Awin Road on the north, Bayintnaung Road on the east, Golfkwin Houng Road on the south and Ywabe on the west. The area of Khittayar Myothit highway terminal is 4.738 acres (0.019 sq.km). It is generally square in shape.

Generally, it is located on flat plain with an elevation of below 100 feet (below 25 meter) above sea level.



Source: Field Survey, 2020.

Figure 2 Structure of Khittayar Myothit Highway Bus Terminal in Pyay City

Terminal has 125 rooms, including 4 buildings having 15 partitions for selling tickets, 5 buildings having 4 partitions for restaurants, 1 building having 32 partitions for seedling items, 2 buildings having 2 partitions for businesses, 3 partitions for Terminal Controlling Committee, 1Guesthouse, 1 rest house, 1 fire brigade, an entrance, an exit, 1 bathroom and 2 partitions for toilets (Figure 2).

Connection between Khittayar Myothit Terminals of Pyay City and Other Areas

With the increasing population, the social and economic development increased. In addition, human's needs have become more varied owing to the innovation of new products. To satisfy the increasing demand, effective transport services for passengers and commodities are needed. Therefore, many highway bus terminals have been established. In order to keep separately from the dense residential areas, Khittayar Myothit highway passenger bus terminal, Nawaday Warehouse and cargo truck compound (freight terminal) have been established.

Table 1 Number of Highway Bus Terminals Serves to State and Region (2020)

State/ Region	Number of serves bus gates
Kayin	3
Kayah	1
Mon	3
Rakhine	4
Shan	5
Within Bago Region	6
Yangon	10
Mandalay	9
Magway	13
Sagaing	1
Ayeyarwady	15
Naypyitaw	6
Total	76

Source: Field Survey 2020.

The movement of people and commodities from one place to another is largely influenced by the accessibility between places. Khittayar Myothit Bus Terminal has been established for the effective control of the passenger bus line services. Locating on the corner of Myothit Awin Road and Bayintnaung Road, it supports bus lines services connecting between Pyay and 5 States and 5 Regions such as Kayin, Kayah, Mon, Rakkhin and Shan states and Yangon, Mandaly (including Naypyitaw), Magway, Sagaing, Ayeyarwady and other townships within Bago regions and with other townships within Bago Region of the country (Transportation of Pyay, 201)

Although the total number of bus gates is 65, total number of bus lines running States and Regions are 76. It is due to combination of transit points and some bus lines have 2 destinations.

According to table 1, connection with Ayeyarwady Region takes the leading role with 15 gates, which is the highest in number, followed by Magway Region. Among the states, connection with Shan State is the highest and Kayah the least.

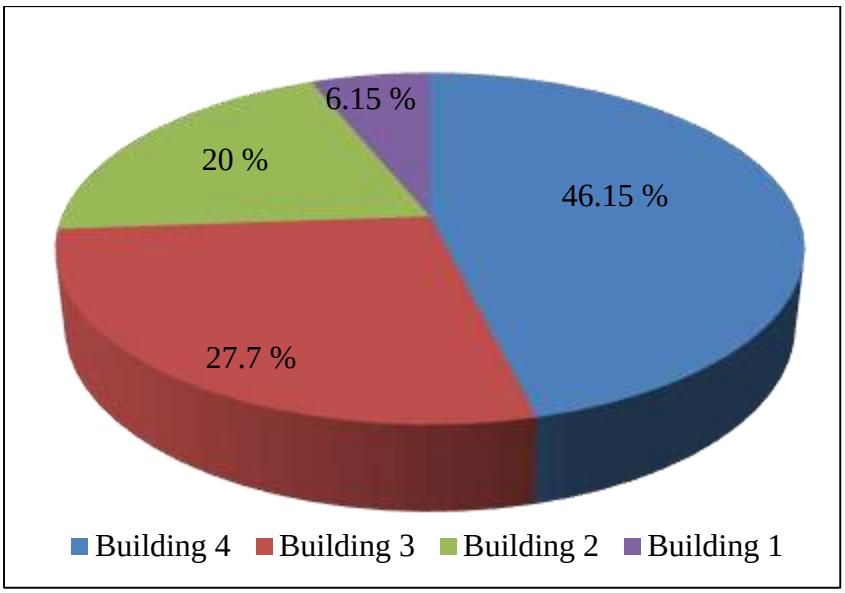
Highway Passenger Bus Transportation Services

In Khittayar Myothit Highway Passenger Bus terminal compound there are 5 streets of which only 3 are used in highway passenger transport service. Highway passenger bus gate is situated in the western part of the terminal. There are 4 buildings having 15 partitions. According to Table 2, there are altogether 65 highway passenger bus gates generally each using each room for conducting related services. With 30 bus gates, building 4 has the largest number which accounts for 46.15 percent of the total bus gates, followed by building 3 with 18 (27.7 percent) bus gates. Building 1 possess the smallest number of gates. The terminal has 60 rooms for highway bus gates. At present only 40 rooms are used for highway passenger transport and remaining 20 rooms for residential and warehouses.

Table 2 Number of Highway Bus Gate Rooms in Khittayar Myothit Highway Passenger Bus Terminal

No.	Building	Highway Bus Gates	Percentage
1.	1	4	6.15
2.	2	13	20
3.	3	18	27.7
4.	4	30	46.15
Total		65	100

Source: Field Survey 2020.



Source: Table 2.

Figure 3 Number of Highway Bus Gate Rooms in Khittayar Myothit Highway Bus Terminal

Most bus gates used only one room for its services, where as some use 2 or 3 rooms for the convenience of the travelers. In some cases two bus gates with limited number of buses use only one room. Moreover a bus terminal or gate with substantial investment has links with several states and regions (Moe Thet Naing, 2007).

The Development of Passenger Transportation

The development of passenger transportation of road transport falls under two categories as into/from and through by passenger bus: (1) the development of passenger flow into/from Pyay City (into/from means flowing into Pyay City from other areas, as well as passenger flow from Pyay City to other areas), and (2) the development of passenger transportation through Pyay City (through means passenger flow passing through Pyay City) (Nwe Yin Min, 2007).

To get reliable facts and data on passenger transportation in 1991 and in 2020 (10 year-period), interviews and field surveys were made at Khittayar Myothit Highway Terminal with authorities of bus gates, passengers and owners.

Passenger buses are categorized depending on their load capacity. There are categorized as (1) buses that can carry below 20 passengers, (2) those between 20 and 40 passengers, and (3) those above 40 passengers. Buses are also classified as normal and special based on quality of the buses.

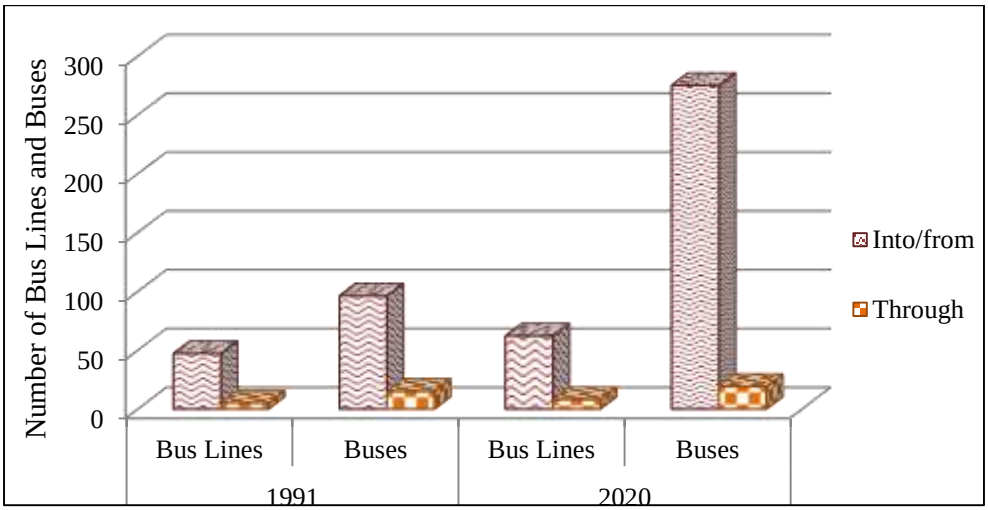
Number of Bus Lines and Buses

Modes of transport include the bus lines, buses supporting the mobility of passengers and road network supporting their movement. The development of passenger transportation, the number of bus line and buses were observed for the study period between 1991 and 2020 and is shown in Table 3 and Figure 4.

Table 3 Average Daily Passenger Bus Lines and Buses Running in the Khittayar Mothit Highway Bus Terminal

Location	1991		2020	
	Bus Lines	Buses	Bus Lines	Buses
Into/from	47	96	62	275
Through	5	15	8	19
Total	52	111	70	294

Source: Field Survey 2020.



Source: Table 3.

Figure 4 Average Daily Passenger Bus Line and Buses Running in the Khittayar Mothit Highway Bus Terminal

According to data obtained from the field survey and interviews, there were 47 bus lines with 96 buses for passenger transportation run into/from of bus terminal, and 5 bus lines with 15 buses ran cross passenger transportation bus terminal. Therefore the total of 52 bus lines with 111 buses runs cross in the highway bus terminal in 1991. In this period many buses were BM and Mini Bus, many roads were metaled and gravel roads and roads was poor in condition.

The average number of passenger bus lines and their number of buses had remarkably increased in 2020. According to interviews, there were 62 bus lines with 275 buses that run into/from, and 8 bus lines and 19 buses that run cross Khittayar Myothit Highway Bus Terminal. In 2020, the number increased to18 bus lines with 183 buses and daily passenger buses over those of 1991. The passenger bus lines and buses increased due to upgrading of existing Yangon-Pyay Road in 1992, and the newly constructed and opened Nawaday Bridge in 1997.

Types of Passenger Bus

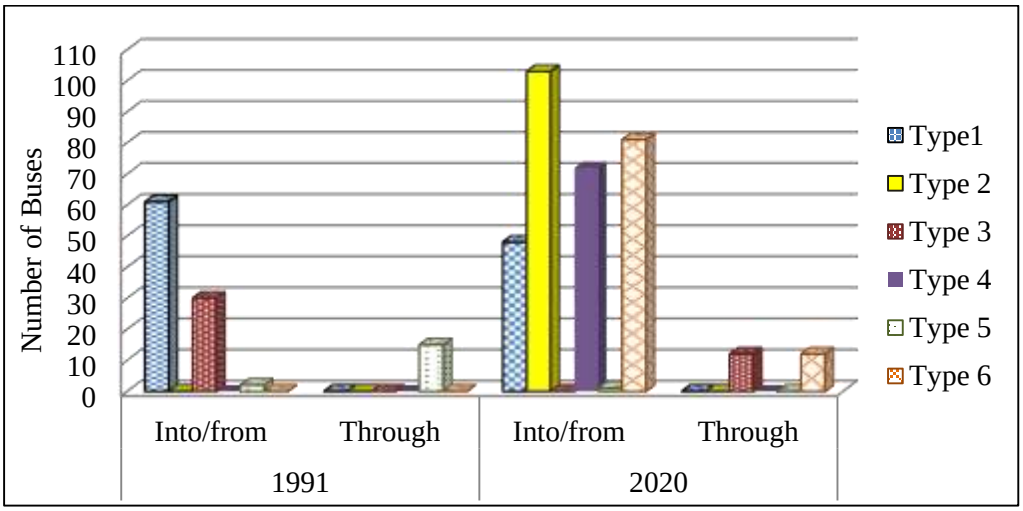
The passenger transport buses are classified into (6) types.

Type (1) includes buses carrying capacity below 20 persons bus (especially in Hilux, Dyna, etc..), type (2) special bus below 20 persons (especially in Bongo, that is comfortable), type (3) capacity between 20 and 40 parsons (passenger bus especially BM types), type (4) capacity between 20 and 40 persons (passengers bus especially Mini bus, that take short time, etc..), type (5) normal bus above 40 persons (passenger bus that takes longer time, low cost, and is uncomfortable etc..) and type (6) special buses above 40 persons capacity (passenger bus that saves time, cost more, and is comfortable, etc..) (Table 4 and Figure 5).

Table 4 Average Daily Passenger Bus Types Running in the Khittayar Myothit Highway Bus Terminal

Location	Type 1		Type 2		Type 3		Type 4		Type 5		Type 6	
	1991	**2020**	**1991**	**2020**	**1991**	**2020**	**1991**	**2020**	**1991**	**2020**	**1991**	**2020**
Into/from	61	48	-	103	30	-	-	72	2	1	-	81
Through	-	-	-	-	-	12	-	-	15	-	-	12
Total	**61**	**48**	**-**	**103**	**30**	**12**	**-**	**72**	**17**	**1**	**-**	**93**

Source: Interview and field Survey.



Source: Table 4

Figure 5 Average Daily Passenger Bus types Running in the Khittayar Myothit Highway Bus Terminal

According to the interviews, the passenger buses running into/from in Khittayar Myothit Highway bus terminal were 2 buses of types (5), 30 buses in type (3) and 61 buses of type (1) in 1991. Type (6) and type (2) were still absent during that period. In this period, passenger buses were only type (1), especially Hilux.

However due to the use of newly invented and upgraded parts of vehicles in highway bus terminal, the number of passenger bus types had distinctively increased in 2020. According to the results of interview, there were 48 buses in type (1), 103 buses in type (2), 12 buses in type (3), 72 buses in type (4), one bus in type (5) and 93 buses in type (6) in 2020. In Type (1), number decreased to 48 buses due to growth of transportation sector and as a consequence, Type (2) increased to 103 numbers. Similarly, Type (4) increased to 72 numbers owing to increase in number of mini bus, but the number of Type (5)'s buses due to increase uses of Type (6)'s buses due to more comfortable.

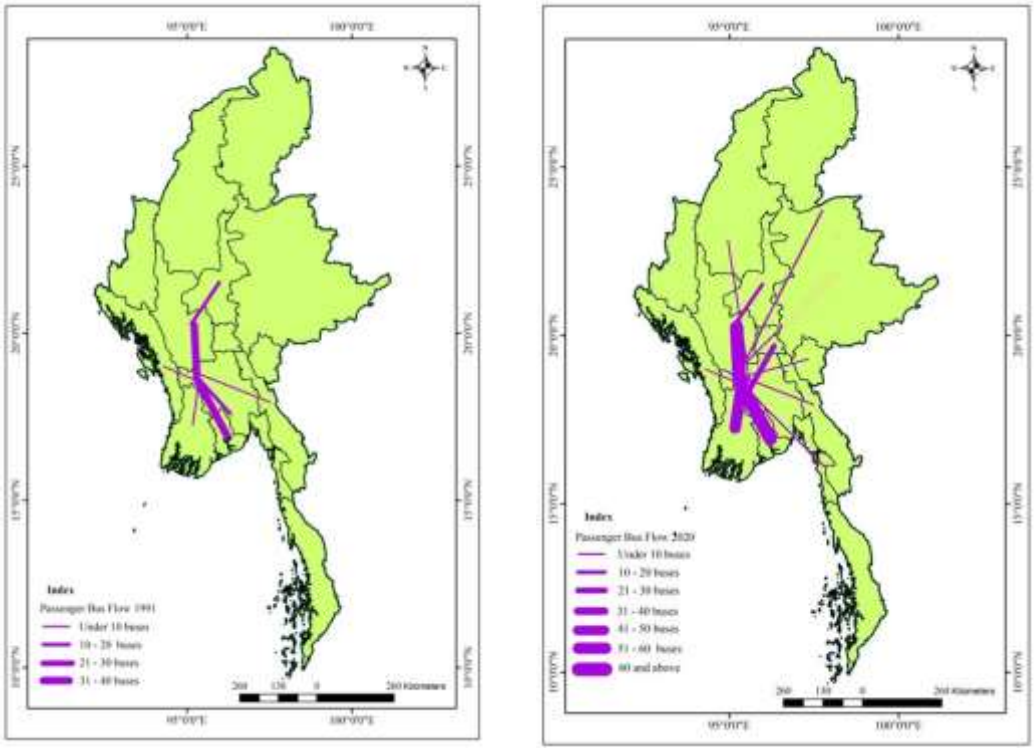
Flow of Passenger Bus

The number of daily passenger bus flow mainly depends on the increasing number of population and job opportunities. The terminals of passenger bus for the study period are shown in Table 5 and Figure 6.

Table 5 Flow Places of Passenger Bus of Khittayar Myothit Highway Bus Terminal

No.	State & Region	Number of Flow Places	
		1991	2020
1.	Yangon	Sawbwargyikone	Aungmingalar
2.	Magway	Magway, Mindone, Aunglan	Magway, Aunglan, Pakkoku, Thayet, Taungtwingyi, Monywa
3.	Mandalay	Mandalay	Mandalay, PyinOolwin, Meiktila
4.	Ayeyarwady	Myanaung, Hinthada	Myanaung, Hinthada, Pathein
5.	Rakhine	Taunggup	Taunggup, Sittwe, Thandwe
6.	Kayin	Hpa-An	Hpa-An, Myawaddy
7.	Sagaing	-	Monywa
8.	Naypyitaw	-	Naypyitaw
9.	Shan	-	Taunggyi, Muse
10.	Mon	-	Mawlamyine
11.	Kayah	-	Loikaw
12.	Other Township of Bago Region	Bago, Paukkhaung	Bago, Paukkhaung, Shwedaung

Source: Field Survey 2020.



Source: Based on Table 5.

Figure 6 Average Daily Passenger Bus Flows in Khittayar Myothit Highway Bus Terminal

According to the data obtained from the interviews, in 1991, the buses ran in Kayin and Rakhine states, and Yangon, Mandalay, Magwe and Ayeyarwady regions and other townships of Bago Region, but in 2020, new areas such as Naypyitaw, Sagaing Regions, Shan, Mon and Kayah states are included. In 1991, the number of passenger was small, and the number of bus lines and buses, low road network connection, and few job opportunities were also small. In 2020, the number of passenger and flow places significantly increased due to improved road network, the people from Myanaung Township in Ayeyarwady Region pass Nawaday Bridge to work in Muse in border area, government employees from Htonbo and Padaung Township go and work in Naypyitaw and improvement of the quality of passenger bus.

The passenger bus flow system including flow of people and commodities are supported by the transport system. Without movement road transport, network would be useless and without road transport network, movement of people and commodities could not occur.

According to figure 5, the daily passenger bus flows was highest in Yangon-Pyay-Magway Highway. After construction of Nawaday Bridge, connection between Pyay and Ayeyarwady Region become more smoothly and accessibility of Pyay become distinctly high.

Travel Time

Faster and more efficient transport system depend on development of road network connection. This process implies a space-time convergence where a greater amount of space can be exchanged with lesser amount of time (Rodrigue, 2006).

For calculate the travel time, trips was selected to Myanaung-Pyay-Mandalay road in 1991 and in 2020. Improvement of transport vehicles (quality of bus and truck), and better infrastructure especially road quality have reduced the travel time.

Bridge is one of the most important factors supporting the development of passenger bus flow. Before the construction of the Nawaday Bridge, Myaungaung-Pyay-Mandalay passenger bus had to rely on the Z-crafts for passing through the Pyay from Myanaung to Mandalay, a person from Myanaung started his trip at 6:00 am, he would arrive Pyay at 9:30 am. At that time, as Pyay-Mandalay buses run in the evening, a person from Pyay started 4:30 pm and he will arrive to Mandalay at 9:00 pm next day and the trip took 27 hours. At present, a person from Myanaung started his trip at 3:30 pm, he will arrive Mandalay at 4:30 am. Therefore, the trip takes only 13 hours and time is saved due to opening the Nawaday Bridge in 1997, improving the quality of the passenger bus types increase in number of trips.

Conclusion

To meet the need for increasing population and for the development of socio-economic activities, effective transportation service is indispensable. For the smooth flow of passengers, Khittayar Myothit Highway Bus Terminal was established in 1991 in Pyay Township. Although the area was only 4.738 acres (0.019 sq.km), the passenger bus gates, restaurant and retail shops are included and the area become congested. Number of buses increased and their services are also larger. Moreover, travel time decreases distinctly because of better roads and vehicles' quality. As number of gates and number of buses increased, problems such as rare parking place are found. Some gates use small Micro Air-con buses for the purpose of reducing space used for buses. Therefore, it is needed to plan to be systematic high way terminal including systematic car parking and necessary to doing research works on bus lines, problems, parking places, etc for the purpose of supporting commodity and people movements that is one of the essentials for the area's development.

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ကြည်၊ ဦးနှင့်အဖွဲ့ (၁၉၉၅)။ "ပြည်မြို့နယ်၏ သယ်ယူပို့ဆောင်ရေး"၊ ရန်ကုန်တကသိုလ် (၇၅)နှစ်မြောက် စိန်ရတုအကြို၊ သုတေသနစာတမ်း၊ ပထဝီဝင်ဌာန၊ ပြည်တကသိုလ်။(in Myanmar)

ပဲခူးတိုင်ဒေသကြီး (ပြည်ခရိုင်) ပြည်မြို့နယ် (၂၀၁၆)။ "ခရီးသည်ပို့ဆောင်ရေး (အဝေးပြေးကွင်းသစ်) ဆောက်လုပ်ရေး လုပ်ငန်းစီမံချက်"၊ ပြည်မြို့(in Myanmar)