

ASSESSMENT ON RURAL WATER RESOURCES AND WATER SUPPLY CONDITION OF PINLAUNG TOWNSHIP, SHAN STATE, MYANMAR

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Abstract

Fresh water resource is essential for daily life. Access to safe water is an important issue today. Pinlaung Township is located in the south western part of Southern Shan State which is one of the highest mountain settlement areas of Southern Shan State which is generally above 1219.2 meters (4000 feet) mean sea level. Pinlaung Township is composed of 26 village tracts and the total population was 183,518 people in 2018 and over 80% is residing in rural area. Pinlaung Township is one of the highest populated areas within Southern Shan State. Based on these reasons, the water resources and its supply should assess for the further development in this area. The main aim of this study is to find out the present situation of water resources and water supply of Pinlaung Township which will support to the planning for water resources management in future. The objectives of this study are to observe the current situation of water resources and water supply of Pinlaung Township, to assess the water supply of this area and to give suggestion management of the water resources and water supply of Pinlaung Township. In order to obtain the reliable data, GIS and some hydrological analysis were applied to acquire the distribution of water resources within Pinlaung Township. Moreover, field observation, key informants interviews survey and open talk interviews were also conducted to the local people. From the results of the interviews survey, water resources and water supply of Pinlaung Township is quite good in present situation due to abundant rainfall and many springs if there is no other impacts like climate change. As population is gradually increasing, Pinlaung is necessary to prepare for water resources and needs to conserve the existing water resources area systematically and wisely.

Keyword: water resources, water supply, Pinlaung Township

Introduction

Fresh water resource is essential for daily life. Water resource is now a vital issue of worldwide situation. Some of the places in the world are facing water scarcity problem. Although water covers 71 percent of the earth's surface, only 4 percent is fresh water and about 0.5% is suitable for human consumption. According to the UN estimation, more than 2.1 billion people are still lacking access to safety drinking water and about 40 percent of global population are facing with water scarcity. In 2016, about 31% of population are living in developing countries and about 40% of people have access to safe water and three fourth of these population live in rural area (Source: UNDP). In Myanmar, hundreds of villages through out the country are likely to face water shortage and are preparing for the future nationwide Shan State, about 889,651 households live in rural area, about 464,345 households have access to acceptable water resource and about 525,306 households is necessary to upgrade (UNICEF, 2016). Pinlaung, being one of the highest rural populated areas in Southern Shan State, which is located on the mountainous area of about 1463.04 meters (4800 feet) above mean sea level, the water resources and its supply should be assessed for the further development in this area where 183538 people are residing. Of which, over 80% of population are living in rural area. The local people mainly depend on the

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rainwater and spring water resources in Pinlaung Township. For this reasons, the water resources and its supply should be assessed for further development in this area.

Aim and Objectives

The main aim of this study is to find out the present situation of water resources, water supply and water quality of Pinlaung Township which will support for the planning of water resources management in the future.

The objectives of the study are

- to observe the current water resources and water supply of Pinlaung Township
- to assess the water resources, water supply and water quality of this area and
- to give suggestions for management of the water resources and water supply of Pinlaung Township.

Data and Method of Study

The secondary sources of statistical data are obtained from previous document such as Thesis and Papers. Furthermore, the necessary additional data is collected from various Administrative Departments like Department of Agriculture, Immigration and National Registration Department, General Administrative Department, Land Records Department, TCDC (Township Clean and Development Council). Primary data are used to Rapid Appraisal Methodology to understand the circumstances of the study area and to meet with the local people by interviewing in the preliminary survey. Primary data come from key informants' interviews survey and open talk interview with local people. Moreover, GIS methods were used to display the distribution of water resources and interpolation method for distribution of rainfall pattern in this study. Some meteorological analysis like effective rainfall is also applied.

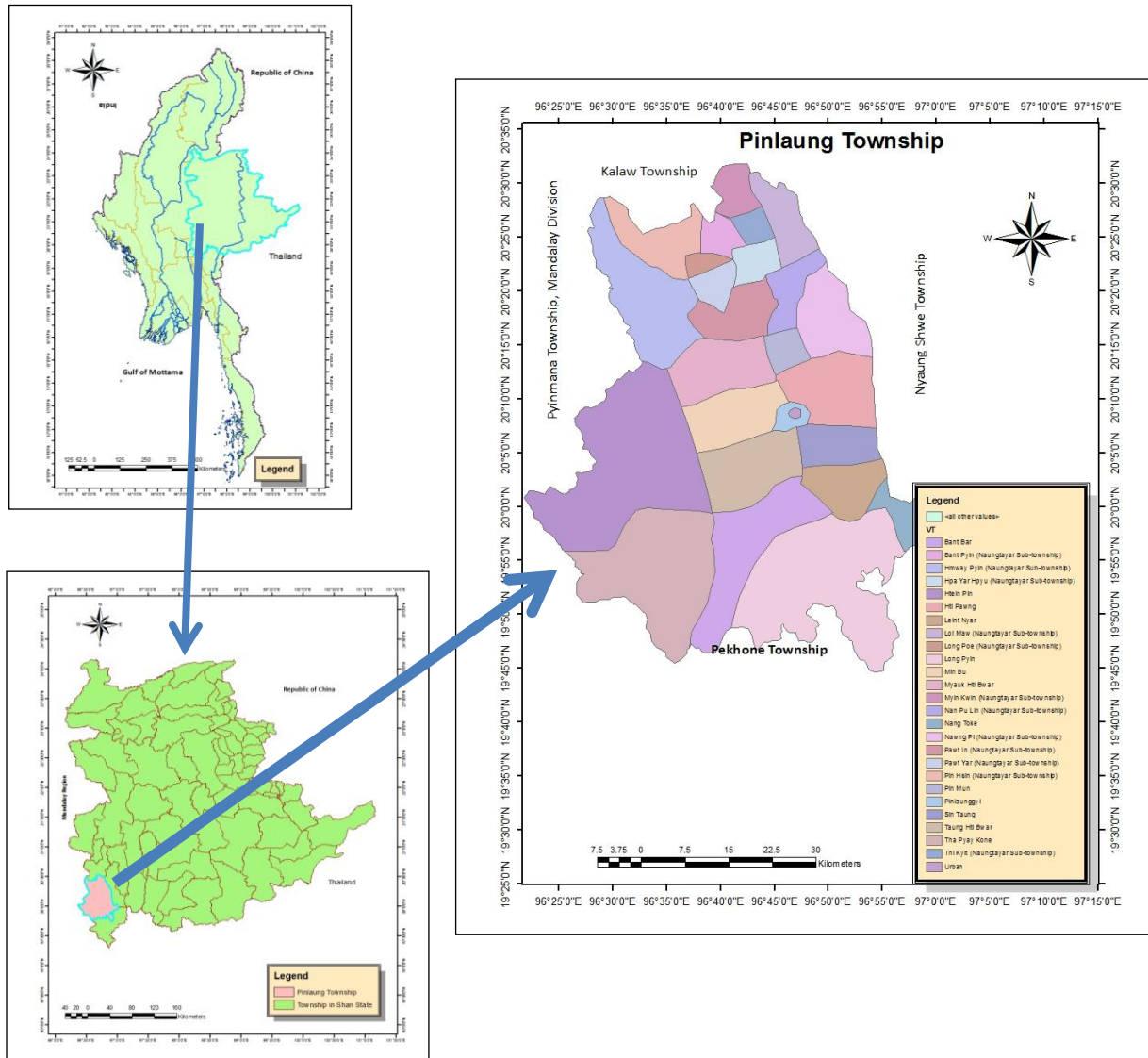
Study Area

Pinlaung Town is situated in the Southern part of the Shan State, between North latitudes 20° 5' and 20°8'; East Longitudes between 96° 46' and 96°48'. Pinlaung Township is located on the mountainous area which is composed with 26 village tracts. Pinlaung is one of the highest hill towns of the Southern Shan State and bounded by Nyaung Shwe Township on the east, Kalaw Township on the north, Pekhone Township on the south and Pyinmana Township, Mandalay Region on the west.

Generally, it is located on the mountain range which has an average height between 1219.2 meters (4000 feet) and 1463.04 meters (4800 feet) above mean sea level. Pinlaung Township has an area of estimated 2,449.1 square kilometer (945.6 square miles). Being a highland area, the topography is nearly undulating, rugged and surrounded by mountain ranges. In accordance with the north- south mountains ranges, many rivers and streams are also flowing north- south direction. Balu Chaung and Paunglaung Chaung are major streams in Pinlaung. Due to its location in Karst land area, many natural springs can be found and they also contribute to water supply of local people.

Although Pinlaung Township is located within Tropical Zone; it has experienced Subtropical Climate because it is situated on the Eastern Highland which is generally

1219.2 meters (over 4000 feet) above mean sea level and is surrounded by mountains which appear as a bowl. Due to its physical characteristics, surface runoff from the surrounding mountains flows into the undulating areas during rainy season where flooding occurs. Although there are substantial amount of rainfall, some of the village tracts are insufficient in water supply. The study area is shown in Figure 1.

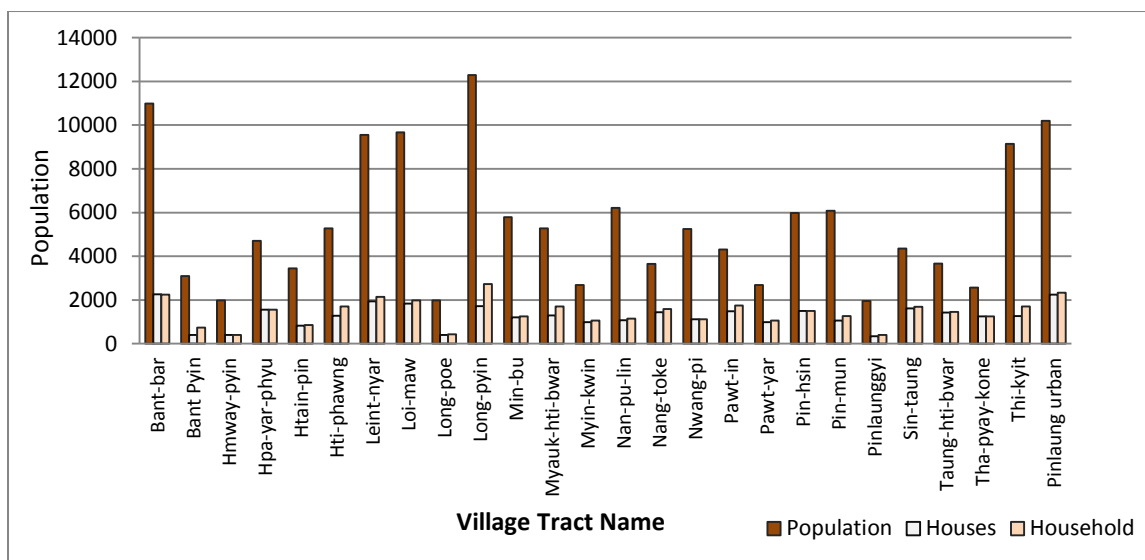


Sources: UTM, (2096-16)

Figure 1 Location Map of Study Area: Pinlaung Township, Southern Shan State, Myanmar

Pinlaung Township is one of the highest populated areas in Southern Shan State and about 86% of population is rural people. In 2018, the total population of Pinlaung Township is about 183538 people which comprise over 37032 households. The main occupation of this area is agriculture.

In term of population distribution, the highest was found in Bantbar, Lonepyin, Leintnyar, loimaw, Titkyit village tracts and Pinlaung Town. See in Figure 2.



Sources: GAD (General Administrative Department), Pinlaung Town in 2018

Figure 2 Village Tract Level Total Population, Houses and Households of Pinlaung Township, Southern Shan State, Myanmar

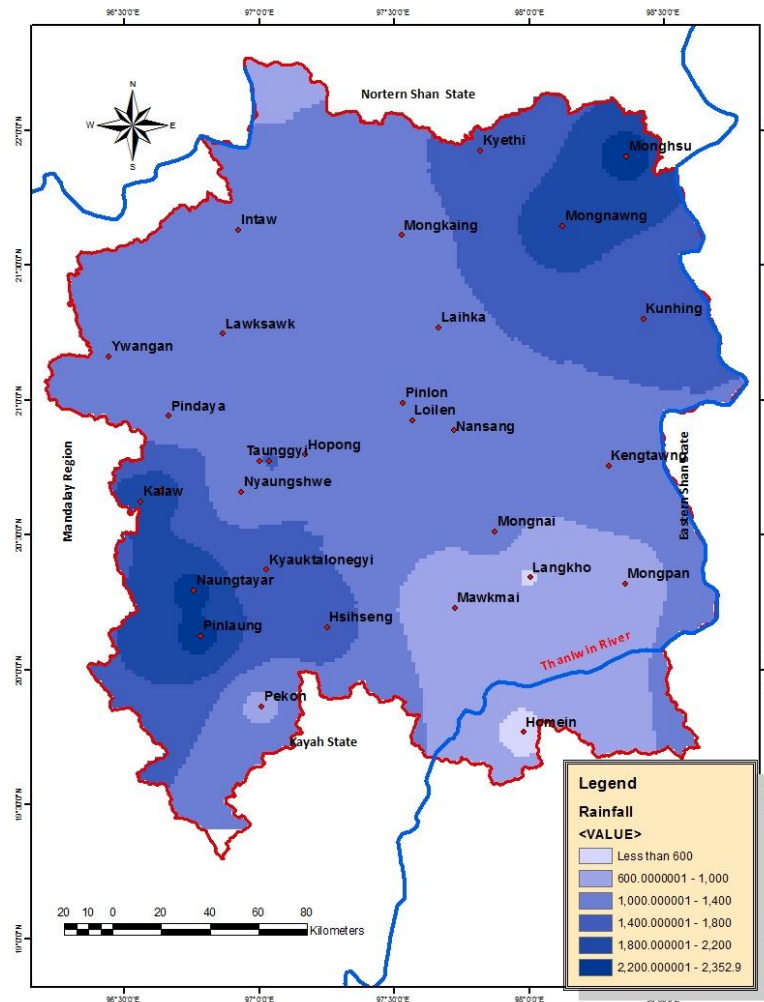
Water Resources and Water Supply of Pinlaung Township

Water resource is one of the most vital resources on earth and it is a renewable resources. There is no life on the earth's surface without water resources, it is essential for all forms of life. Two-third of the earth's surface is covered by water; out of this 97 percent are ocean water and the rest (3 percent) is fresh water resource in which about two-third are in the form of ice and glacier and the rest is found as rivers, lakes and ground water.

Generally speaking, the main water resources in Pinlaung Township can be divided into four: namely rainwater, surface water (stream, river, pond and lake water), subsurface water (dug wells, springs and infiltration galleries) and groundwater. In Pinlaung Township, reservoirs are artificial lakes where source of water come from natural springs and stored as fresh water for distribution to the local residents.

Rainwater Resources in Pinlaung Township

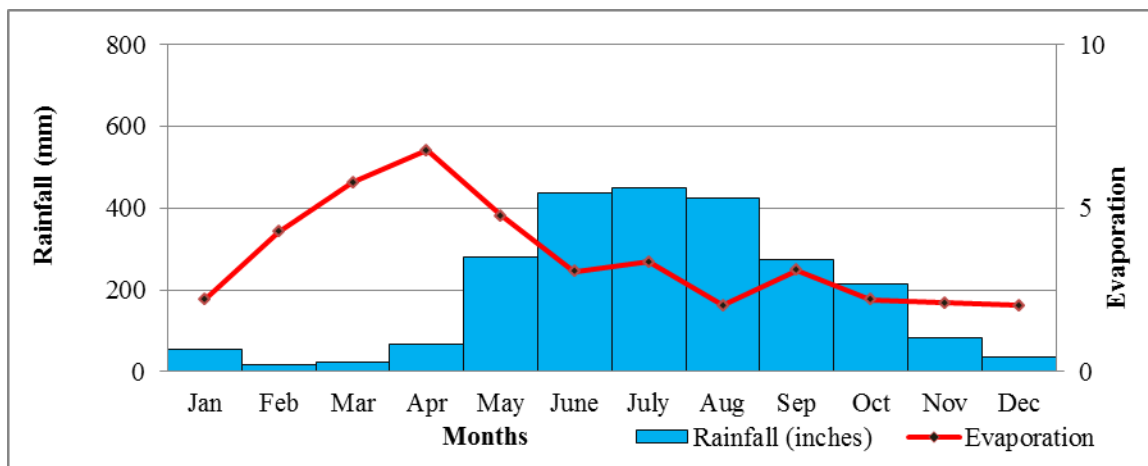
Pinlaung Township have experienced Humid Mesothermal Climate, where average annual total rainfall is about 2253mm (88.71 inches) between 1999 and 2017 which can be said that Pinlaung has sufficient amount of rainfall to be compared with surrounding area. See in Figure 3.



Sources: Meteorological and Hydrological Departments and Department of Agriculture

Figure 3 Rainfall Pattern of Southern Shan State: Pinlaung is one of the highest amounts of Rainfall within Southern Shan State

Therefore rain water is one of the valuable water resources for Pinlaung Township particularly in the rainy season. Pinlaung is located at an elevation of 1463.04mm (4800 feet) above mean sea level; the temperature is not very high. During the monsoon period, between the months from June to October, the rain water amount and evaporation rate can be calculated. These conditions control the effective rainfall of Pinlaung area and it can benefit for the water supply as fresh water resource not only within the rainy season but also it can be distributed after monsoon period if it can be systematically stored. See Figure 4.



Sources: Department of Agriculture, Pinlaung Town

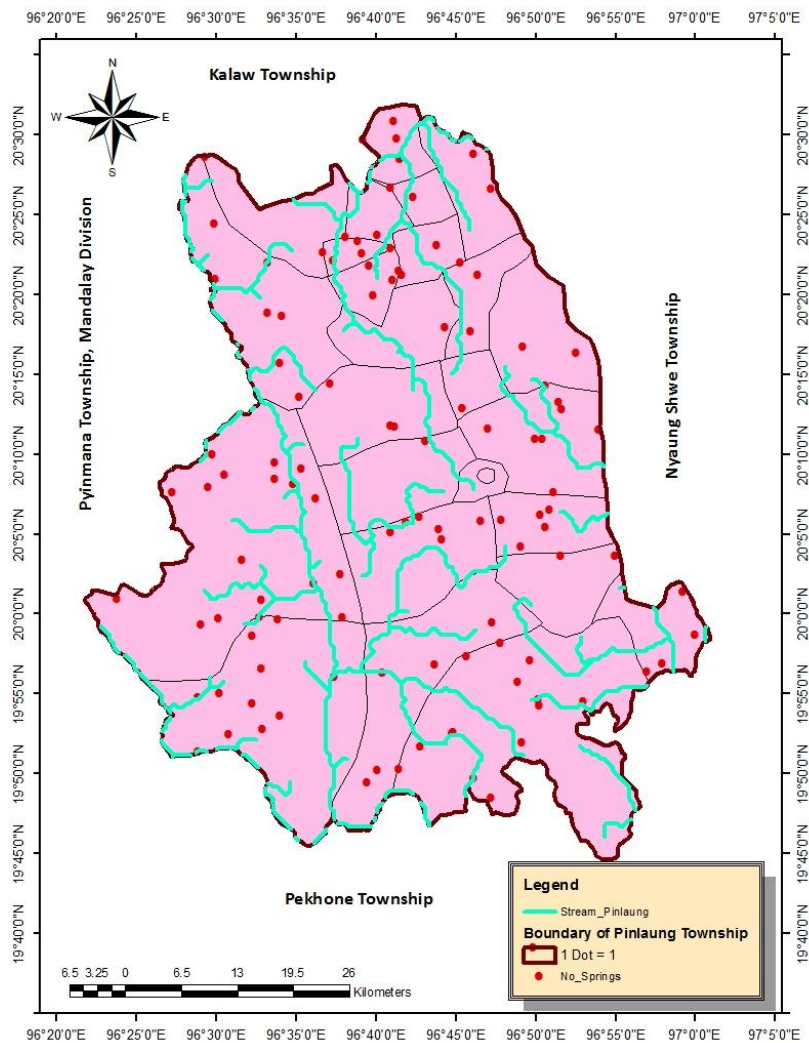
Figure 4 Effective Rainfall of Pinlaung from 1999 to 2017

The rain water is totally related with the surface water as well as ground water recharging. Thus, the rainwater is strongly related to surface water and ground water due to the geological structuring. If the rain water could be systematically managed, it can support water supply sufficiently to the local people than the present saturation.

Surface Water Resource in Pinlaung Township

Surface water includes rivers, creeks and wetlands. Most surface water comes from rainfall (precipitation) runoff into the surrounding land areas (catchment). They are usually in the form of rivers, lakes, springs and swamps. In Pinlaung Township area, the surface water is available from ponds, lakes, streams, and rivers.

In Pinlaung Township, Balu Chaung is the main stream in this township which is located on the northeastern part of Pinlaung Town flowing into the east of Pinlaung Town and reaches the Inle Lake near Indein Village from which local people mainly used for agricultural purpose. Apart from this stream and its streamlets, seven ponds are also found in Pinlaung Township, of which 4 ponds are contributed to the local water supply in urban area and the rest are in Hti-phoung and Minbu village tracts for fresh water resources in Pinlaung Township. Most of them are manmade ponds (reservoirs) where water comes from spring water sources which combined with rainwater harvesting. See Figure 5.



Source: Based on MIMU and DWIR, Taunggyi in 2019

Figure 5 Surface Water (streams) and Subsurface Water (springs) Water Resources in Pinlaung Township

Sub- Surface Water and Ground Water Resources in Pinlaung Township

Being on the limestone area, there is some water exposure as springs which are included to subsurface water in Pinlaung Township. There are about 117 springs in Pinlaung Township which is mainly contributed as the water resources for rural people and for water supply in urban area as well.

Springs water resources like Nam Hu Springs (storage capacity about 10,000 gallons), Bant Pe' spring (storage capacity about 10,000 gallons), Tawya kyaung spring (storage capacity about 5,000 gallons) and Balu Chaung spring (storage capacity about 100 million gallons) are converted as water supply to the Pinlaung Township by collecting in reservoirs.

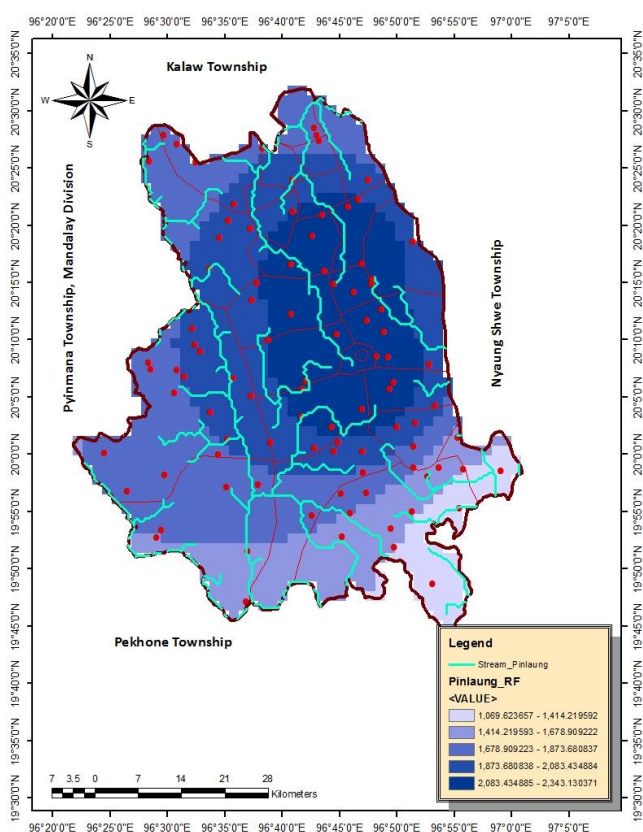
Apart from the springs, hand dug wells are contributed to the sub-surface water resources in Pinlaung Township. Hand dug wells are usually quite shallow, typically less than 15.24 meter (50 feet) deep. Additionally, the private sectors of 70 hand dug wells are found in Pinlaung. Ground water is also contributed as a water resource for Pinlaung Township. As water supply is insufficient, the local people depend on ground water sources. There are 40 tube wells in

Pinlaung Town and 70 tube wells in rural area especially in Hti Phuong Village tracts where no spring exist.

Distribution of Water Resources and Water Supply in Pinlaung Township

According to the expert interview survey, of 26 village tracts in Pinlaung Township, 24 village tracts strongly depend on rainwater resource due to its availability and difficulty of obtaining ground water.

About 22 village tracts used combination of rainwater and spring water, 4 village tracts depend on ground water, 1 village tract depend only on spring water and ground water and 3 village tracts depend rainwater and stream water. Among four main water resources, rainwater source is most significant in Pinlaung Township because the amount of rainfall is one of the highest within Southern Shan State. The second available water resource in this area is springs which contribute to the water supply of urban people as well as rural area. An additional water resource in Pinlaung Township is ground water where there is no spring water resource, mostly are found in the Htiphoung and Bantbar and Pinlaung village tracts. In Taunghtiwar, Thayaykone and Sintaung village tracts are on the slope area where the local people mainly depend only on rainwater due to difficult to obtaining ground water resources. It is significant that in Pwetyar, Hpinsin and Nang-toke village tracts where the local people depend on river water resources due to unavailability of spring water and difficulty of ground water resource. See in Figure 7.



Village Tract	rainwater	pond	spring	river	wells
Bantbar	**		**		**
Bant Pyin	**		**		
Hmwaypyin	**		**		
Hpayarphyu	**		**		
Htainpin		*	**		
Htiphawng	**	*			**
Leintnyar	**				
Loimaw	**		**		
Longpoe	**		**		
Longpyin	**		**		
Minbu	**	*	**		*
Myaukhtibwar	*		**		
Myinkwin	**		**		
Nanpulwin	**				
Nangtoke	**		**	*	
Nwangpi	**		**		
Pawtin	**		**		
Pawtyar	**		**	**	
Pinhsin	**			**	
Pinmun	**		**		
Pinlaunggyi	**		**		*
Sintaung	**		**		
Taunghtibwar	**		**		
Thapyaykone	**		**		
Thikyit	**		**		

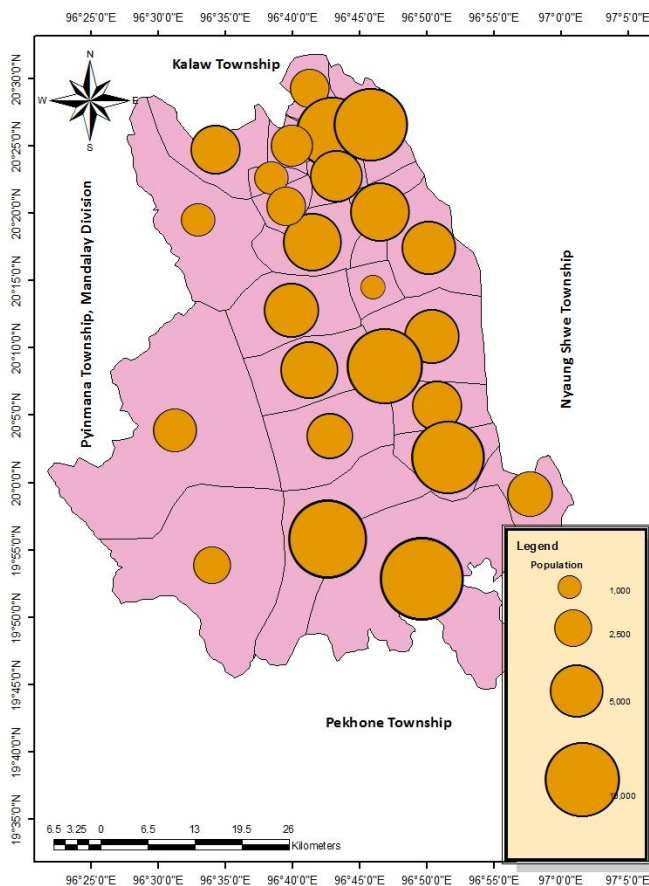
Source: MIMU and DWIR, Taunggyi and field observation, 2019

Figure 7 Distribution of Water Resources and Water Supply of Pinlaung Township

Rural Water Supply in Pinlaung Township

According to the TCDC of Pinlaung, the water consumption for urban people in Pinlaung Township is regarded as 20 gallons per person per day.

As above mentioned, Pinlaung is composed with Pinlaung Town and 26 village tracts. In urban area only, there are 1465 households and the total population is 9116 persons. Therefore, the necessity of water supply is about 182320 gallons which is estimated for 20 gallons/ day/ person. For the whole township, the water supply 13,948,888 Liters (3,670,760 gallons) per day (for 183538 persons x 20 gallons) is needed. According to the UNDP, the estimated rural water requirement is regarded in household level as 4500 liter per day which comes from the minimum basic drinking and domestic water requirement of a family (six persons) is 40 liters/day. Thus, the water storage requirement for dry season of 3 months will be 3 x 30 x 40 x 1.5 which is equal 4500 L per household (1 Liter = 0. 264 gallons) in average. In this study, the requirement of water resource for Pinlaung Township could be estimated. See in Figure 8.



VT Name	House hold	*5400 L/ HH	Estimated Requirement
Bantbar	2245	5400	12123000
Bant Pyin	733	5400	3958200
Hmwaypyin	396	5400	2138400
Hpayarphyu	1557	5400	8407800
Htainpin	858	5400	4633200
Htiphawng	1700	5400	9180000
Leintnyar	2144	5400	11577600
Loimaw	1976	5400	10670400
Longpoe	435	5400	2349000
Longpyin	2734	5400	14763600
Minbu	1245	5400	6723000
Myaukhtibwar	1700	5400	9180000
Myinwin	1062	5400	5734800
Nanpulin	1149	5400	6204600
Nangtoke	1592	5400	8596800
Nwangpi	1111	5400	5999400
Pawtin	1743	5400	9412200
Pawtyar	1062	5400	5734800
Pinhsin	1495	5400	8073000
Pinmun	1257	5400	6787800
Pinlaunggyi	400	5400	2160000
Sintaung	1687	5400	9109800
Taunghtibwar	1458	5400	7873200
Thapyaykone	1246	5400	6728400
Thikyit	1710	5400	9234000
Pinlaung urban	2337	5400	12619800

Source: MIMU and GAD, Pinlaung Town, 2018

Figure 8 Population Distribution and Estimated Water Requirement in Pinlaung Township

But, the water supply in rural area is different from urban area. Therefore, the rural people depends only rainwater in monsoon period. According to the expert interview survey, about 98% of rural people in Pinlaung Township depend only on rainwater in monsoon period as well as in dry season by storing rainwater. In some of village tracts like Nawngpi, Myaukhtibwar, Leintnyar and Bentber village tracts, the local people used only on rainwater. They store rainwater in small tank which is normally about 6 meters (20 feet) x 3 meters (10 feet) with concrete in their compound.

From June to October, the local people depend only on rainwater due to abundant rainfall and they store it in various ways for dry season. From October to January, they use other sources like spring water, stream water, and ground water as availability of water sources. From February to May, the local people used on stored rainwater because spring water and ground water level are decreased.

Table 2 Year Round Water Resources and its Consumption of Pinlaung Township

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
spring	Collected/ harvested Rainwater				Rainwater					Spring/ Stream	

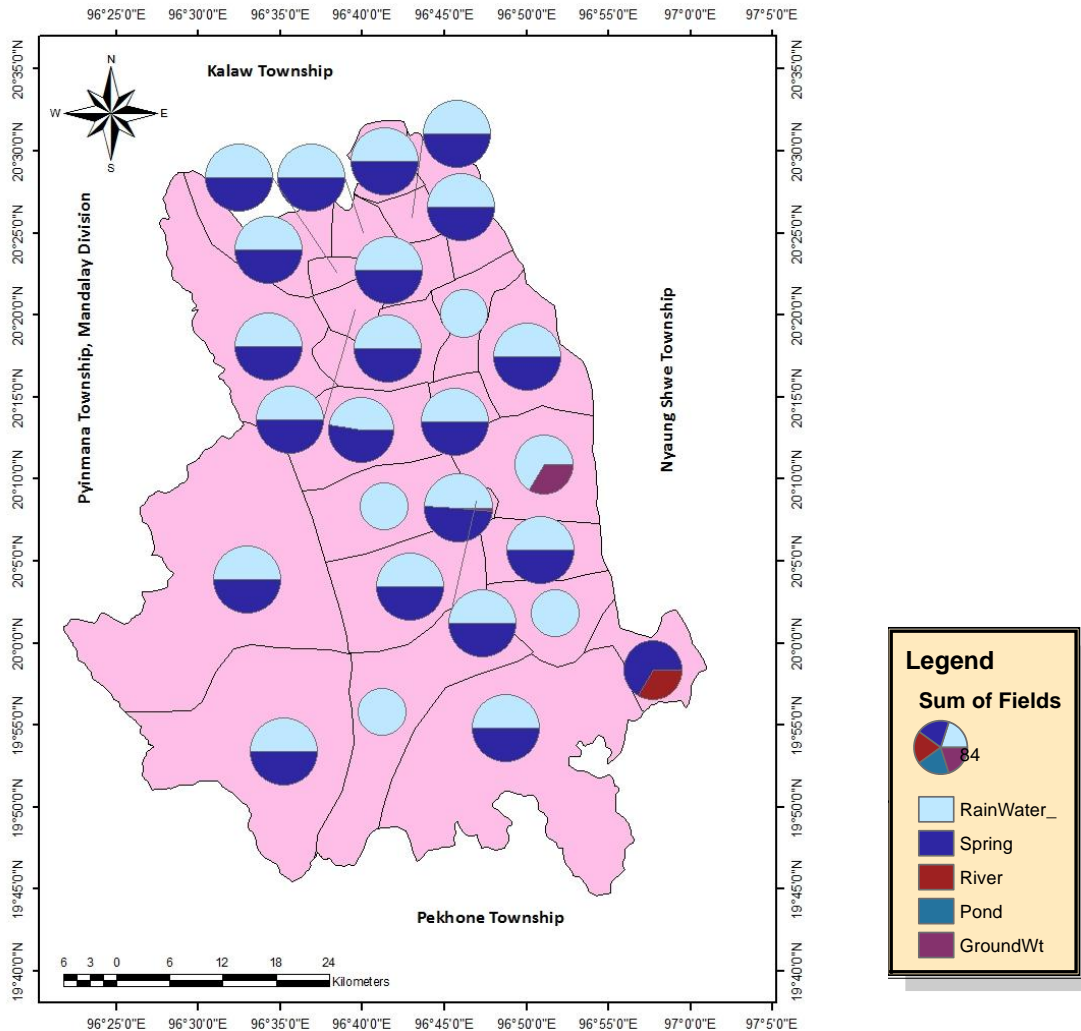
Source: Interview Survey, 2018

Another water source for rural people in Pinlaung Township is sub-surface water (springs) and ground water (wells). The traditional and most common method of obtaining groundwater in rural area is hand-dug wells. In 2017, there are 40 hand dug wells in Pinlaung Township; the depth is between 5 to 15 meters (15 to 50 feet) but some village tracts has difficult to obtain from dug well due to geologically structure. Therefore, they tried to get the water from deeper ground source as tube wells. The highest amount of tube wells is found in Pinlaung Town accounted for 70 tube wells and followed by Htiphaung Village Tract with 50, Bant-bar Village Tracts with 7 and Pinlaunggyi Village Tract with 3 tube wells, respectively which is mainly for drinking water purpose. The depth of tube well is varied between 45 to 137 meters (150 to 450 feet). Water level is quite fluctuated; it is normally high in the rainy season and low in the dry season. The remaining village tracts are used particularly rainwater sources by harvesting system.

Apart from Htiphaung, Leintnyar, Nantpulin and Pinsin village tracts where there are no springs, all the remaining village tracts use spring water after monsoon period. But, some of the springs are threatened due to deforestation and agricultural extension in this area. Some are dried up in dry season. It is significant that the Pinsin, Pawetyar and Nangtoke village tracts where there is no spring due to its location the local people depend on river water source.

According to the field observation, spring water supply is very weak and the local people manage by themselves. It is strongly necessary to upgrade and conserve systematically in every spring area.

In Pinlaung Township, about 90% of population is engaged in agriculture. Therefore, the agricultural water uses is important in this area. About 76% of village tracts depend on rainwater sources for agriculture and about 11% of village tracts rely on spring water. Apart from this about 11.5 % of village tracts used for river water for agriculture purpose. See in Figure 9.



Source: Township Development Committee, Pinlaung Township

Figure 9 Water Supply and their Uses of Pinlaung Township, Southern Shan State

Assessment of Water Quality in Pinlaung Township

The drinking water quality should be tested; some water quality variables are assessed in this study. In Pinlaung, the main water sources are from Municipal water supply which comes from the reservoir by harvesting from spring sources. As already mentioned above, the main water resources of Pinlaung Township are 1) Nam Hu Spring, 2) Bant pe’ Spring, 3) Tawya Kyaung Spring and 4) Balu Chaung. In this study, the quality of water is assessed from these water sources. In this study, the following 15 parameters are measured from 4 main water resources. See in the following Table (4.1)

Table 3 Water Quality Measurement on Main Sources of Water in Pinlaung

Sr.	Parameter	Unit	Sources of Water				WHO/EU Standards
			1	2	3	4	
1	Colour	TCU	Nil	Nil	Nil	Nil	15
2	Odour		Nil	Nil	Nil	Nil	-
3	Turbidity	NTU	4	3	4	3	5
4	PH		6.8	7	6.5	7.2	<8.0
5	Iron	mg/L	0.26	0.23	0.24	0.25	0.3
6	Fluorite (F)	mg/L	0.2	0.1	0.3	0.3	1.5
7	Lead (Pb)	mg/L	Nil	Nil	Nil	Nil	0.01
8	Arsenic (As)	mg/L	Nil	Nil	Nil	Nil	0.01
9	Nitrate (N,NO ₃)	mg/L	Nil	Nil	Nil	Nil	50
10	Conductivity	mg/L	422	405	452	456	-
11	Chlorine (CL)	mg/L	4	5	6	6	250
12	Manganese	mg/L	Nil	Nil	Nil	Nil	0.05
13	Sulphate (SO ₂)	mg/L	15	18	14	20	200
14	Sodium Chloride (NaCl)	mg/L	9	8	10	10	-
15	Dissolved Solids	mg/L	150	190	191	200	1000

Sources: Township Clean and Development Council, Palaung and Field Measurement

As a result from the measurement, it is significant that there is no value in measuring of colour, odour, Lead (Pb), Arsenic (As), Nitrate (N, NO₃), Manganese (Mg). The values are found in pH, Turbidity, Iron, Fluorite, Conductivity, Chlorine, Sulphate, Sodium Chloride, and Dissolved Solids. Almost all the water qualities are acceptable of WHO/EU Standard which falls in permissible level.

From the assessment of water quality from various sample sites, it can be said that the water quality of Pinlaung is acceptable level and these water samples are used for water supply. In this measurement, the pH value indicates that it is slightly acidic in every sources of water supply area. According to the interview survey from local people, about 80 % of drinking water depends on purified drinking water and the remaining used after boiling.

Conclusion

Being on the high settlement area and one of the populated areas of Southern Shan State, water resources of Pinlaung Township is important for the local people. Moreover, about 80% of population in Pinlaung Township lives in rural area. The rural people mainly used water from rainwater and spring water source. Additionally, about 90% of the rural population used rainwater and river water for agriculture purposes.

Although Pinlaung has abundant amount of rainfall than other area within Taunggyi District, some village tracts in Pinlaung township experiences insufficient water supply. It is favorable for runoff condition from the mountain slope to the lowland area which indicates necessity for rainwater harvesting. Also it is necessary for systematic storage system privately or for public to support water supply after monsoon period. Apart from very high settlement areas in Pinlaung Township, there is no great problem in water sources and water supply due to abundant

rainfall in monsoon period. But the problem occurs in the dry season. Nevertheless, there might be potential problem in the future due to climate change impact and population growth.

According to the interview survey with local people, the problem in Pinlaung Township is that the decreasing amount of water output for every springs is due to land cover changes, deforestation and climate change. Some of the springs disappeared today. Spring is the second highest availability of water sources in Pinlaung Township after rainwater but it is also related to the rainfall condition. Therefore, it is very important for conservation of each and every spring in this area. For sustainable water management, it is necessary to harvest rainwater source systematically for water supply of rural people. Additionally, it is important to conserve urgently land use changes and deforestation around catchment area.

In conclusion, of over 500 villages in Pinlaung Township, only 20 villages can access water supply by Department of Rural Development and only a few villages are under UNDP project. Water resources for rural area in Pinlaung Township are mainly dependent on rainwater and spring water. Rainwater storage capacity is mostly insufficient after monsoon period because of unsystematic storage system, some of the storage capacity is very limited necessary to find the right place in the village tract for easy access due to inadequate facilities. Therefore, for sustainable water management of water resources in Pinlaung Township, it should conserve from household level management to community level management for rainwater, it should be prepared for alternative water resource like spring and ground water for climate change and individual spring and its catchment are urgently needed to protect due to population growth and agricultural extension. According to the WHO, about 80% of diseases are related with water, thus storage system, conservation should promote from household level to community level in this area.

Acknowledgement

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