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In summing up, health care centres adequately support local people in Sanchaung Township. As health care centres are mainly concentrated in densely populated area, it can support most population in the area. As they are located in the accessible area, local people can go there easily. Health care centres, private clinics and pharmacy shops are supporting each others and they all serve local people's health matters. The highest concentrated areas are within 400 meters buffer zone in southern part of Myenigone Ward and the distribution of health care centres in Sanchaung Township supports the private and public hospitals and this distribution is mainly controlled by accessibility and population density. In the future, local people will surely get better health care from existing health care centres because of better accessibility and growth of health care centres. To get complete understanding of existing health care centres, it is necessary to do further researches on facilities used in health care centres, number of specialists, as well as services given by health care centres of Sanchaung Township.

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We are greatly indebted to Dr. Tin Maung Hla, Rector, and Yangon University of Distance Education, for his kind permission to submit this research for the University Research Journal. We also thank Dr Khin Thant Sin, Pro Rector, and Yangon University of Distance Education, for her encouragement and supervision. We would also like to extend our thanks to all our teachers for their guidance and to our friends for their help in doing this research work.

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A Study of Crop-Climate Relationship in Hlegu Township

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Abstract

This research work analyzes the physical factors of the area, especially climate factors, which are of critical importance for the crop- climate relationship in Hlegu Township. The main objectives are to study the relationship between crop and climate, to present climatic conditions of the study area and to show suitable crops for study area.As its chief economy is based on agriculture, it can somehow satisfy the high food demand of Yangon City. Paddy cultivation plays important role in Hlegu Township. People living in rural areas mainly depend on agriculture and most farmers in rural areas cultivate paddy. The paper highlights climate elements such as temperature, rainfall, day length and humidity.The crops mainly grown are monsoon paddy, groundnut, sesame and sunflower. To highlight the suitable crops for study area, climatic data were used for 35-year period (1982 and 2017). Climate data were obtained from meteorology and hydrology department in Yangon. To do the research work, primary and second data were collected through 3 field trips. Physical factors and human factors, data and information were obtained from library, departments concerned, field surveys and interviews were organized and analyzed. According to the results, sunflower and sesame are not well suited for the study area. Others crop such as monson paddy, groundnut and sunflower are favorable.

Keywords: crop-climate relationship, suitable crops and monsoon paddy

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Introduction

Hlegu Township is located in the northeastern part of Yangon Region. The effective use of climate condition is so important to boost the yield and to sustain the agriculture. The chief controlling factors of the climatic conditions of Hlegu Township are location, relief and seasonal winds. The area falls within the tropical monsoon climatic regime and both seasonal and diurnal ranges of temperature are small due to being close to the sea. The mean annual rainfall of the township is 2518 mm mainly received in the high sun period from June to October and dries in the low-sun period. The average temperature of the coldest month (January) is 23.95 ˚C. The study area thus experiences the Tropical Monsoon climatic (Amwg) according to the Valadimir Koppen's climatic classification scheme. The study of crop climate relation, climate elements are important factors. Climate elements are temperature, precipitation, day length and humidity. Climate is directly affects the crop growth and productive potential of each crop. In Myanmar, about one third of the population depend mainly on agriculture especially paddy cultivation. In Hlegu Township, paddy is the most significant crop.Rain-fed lowland paddy is grown extensively. Rain-fed lowland paddy field is divided into two kinds, these are monsoon and summer paddy cultivation. Monsoon paddy is extensively cultivated due to water availability from monsoon rain. Monsoon paddy is sown in mid-June and harvested in October or November. The study crops are monsoon paddy, groundnut, sesame, and sunflower for crop-climate relationship.

Aim

The aim of this study is to assess the crop- climate relationship.

Objectives

The objective are -

- to know climatic condition in study area,
- to study climate elements and its effects on the crops cultivation and
- to suggest suitable crops in study area

Methodology

In this paper, the physical factors especially climatic data also are used. The data information was obtained from libraries, departments concerned, field surveys and also interviews were organized and analyzed. Climate data obtains from meteorology and hydrology department. The facts and data available were tabulated, calculated and presented in diagrams. Secondary data were collected from various sources and used in the study. Questionnaires were prepared in advance and an intensive field trip was made to interviews local people, farmers and government staff. Statistical analyses for these training areas were performed to find out their consistency. The facts and data available are tabulated, calculated and presented in diagrams.

Study Area

Hlegu Township is located in the north-eastern part of Yangon Region. It is situated about 29 miles away from Yangon City and in fringe area of Yangon Region. (Figure 1) . It has an area of 1495 sq. km and represents 14.25 percent of Yangon Region (Myint Thida, 2012). Hlegu Township consists of 5 wards and 52 village Tracts with 176 villages in the rural area. It is located on the Yangon-Bago High Way Road. The area produces paddy and other crops that support Yangon City and nearby town.

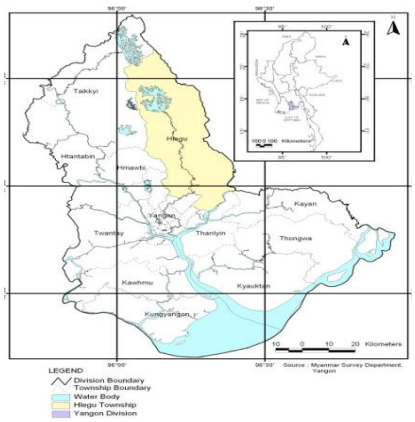

Figure 1 Location of Hlegu Township (Source: Land Records Department, Hlegu Township)

Physical factors of the study area

Hlegu Township located in the eastern margin of the Ayeyarwaddy Deltaic region, occupies vast tracts of lowland flanked by low hills and mountain spurs of Bago Yoma in the north and northwest. The low land covers about four- fifth of the township's area (Than Htay, 1990). There are several low hills emerging out of the plain. Generally the land slopes towards the south.Therefore, most of the cultivated areaare found in the southern part of the area. The Ngamoeyeik creek is the most prominent stream, highly supportive to agricultural activities of the township (Win Pa Pa Myo, 2001). The existing climatic conditions support cultivation of the area. Soils of the study area vary from place to place depending on relief, parent material and natural vegetation. Soils is important for agriculture of the township . Although climate is one of the major soil forming factors, its effect on variation of soil type is less pronounced as the entire study area experiences almost the same climatic conditations.

Table 1 Temperature (°C) and Rainfall (mm) of Hlegu Township

Category of Temperature(°C)	J	F	M	A	M	J	J	A	S	O	N	D
Maximum Temperature (°C)	32.2	34.7	36.9	37.9	34.7	30.5	30.1	29.6	30.7	31.7	31.8	31.1
Minimum Temperature (°C)	15.7	17.0	20.1	23.5	24.7	24.2	24.0	24.1	24	23.5	21.3	17.2
Mean Temperature (°C)	23.95	25.9	28.5	30.7	29.7	27.4	27.1	26.9	27.4	27.6	26.6	24.2
Rainfall (mm)	0	7	12	20	238	548	571	568	346	141	63	4
Rainy Days	.05	.14	.55	1.45	11.23	23.6	25.27	25.4	18.45	9.23	2.77	0.23

Source: Meteorology and Hydrology Department, Yangon

Result and Findings

Temperatur, Rainfall and plants Growth

Temperature has direct influence on the photosynthesis and growth of plants.

Temperature and Paddy

The optimum requirement of temperature for paddy varies with the stages of plant growth. At the initial stage temperature of not less than 10˚C is required for paddy seed germination. In Helga Township, the temperature in the early monsoon period, when the paddy seeds are sown, is well over 10˚C. Thus, there is no problem for paddy plants. At the development stage, it needs an optimum temperature of 27˚C. The temperature of study area is about 27.1˚C and thus the paddy plants grow well at this stage. Paddy requires a temperature ranging between 25˚C and 35˚C at the reproductive stage. The temperature at study area is about 26.9˚C. Paddy needs higher temperature at the ripening stage. The need at this stage is not less than 30.8˚C and Hlegu experiences 27.6˚C during that period. Generally, the temperature of the study area is well suited for paddy plants. See table 2.

Table 2 Growing period for monsoon paddy (135) days (June to October)

Stages	Crop requirement		Actual condition	
	Temperature ˚ C	Rainfall mm	Temperature ˚ C	Rainfall mm
Initial stage(Jun-July)	Over 10˚ C	75-300	27.4	547
Development stage (July-Aug)	27	125-300	27.1	582
Reproductive stage (Aug- Sept)	25-35	125-300	26.9	336
Ripening stage (Sep-Oct)	30.8	75-200	27.6	141

Source: Department of Agricultural Land Management and Statistics, Hlegu Township

Rainfall and Paddy

Paddy that thrives in the flooded field requires relatively more water than many other crops. At this initial stage the amount of water require is 75mm to 300mm.The township has 547 mm. Thus it is sufficient for this stage. At the development stage and reproductive stage, paddy needs 125- 300mm of rainfall. Study area receives 582 mm and 336 mm and a larger proportion is in excess. Unless the excess water cannot be somehow drained, it can retard the plant growth. Insufficient water at this stage can affect the yield. At the harvest stage, water need for paddy 75-200mm and township receives 141 mm at this period. Precipitation during the growing period is sufficient for monsoon paddy in Hlegu Township. See table 2.

Temperature and Pulses

The main pulses grown are green-gram, black-gram, bocate and pesingon. All kinds of pulses require a minimum temperature of 10˚C to 15˚C for seed germination. The mean minimum temperature of Hlegu Township is 21.3˚C and the average mean 27˚C in November. The optimum temperature for black gram at initial stage is between 20˚C and 30˚C. It is 24˚C to 30˚C for green gram. Thus, all three kinds of beans are well suited to the temperature of the study area. At the development stage, the favourable temperatures for these pluses are between 18˚C and 30˚C. The mean temperature of study area is 24.2˚C, which is slightly greater than the required temperature. Black gram usually begins flowering and forms seeds when the day length is short. The optimum temperature data is related to the flowering and harvest stages for pulses are not available.

Rainfall and Pulses

Pulses are second important crop in the study area which requires 400-500 mm of rain during the growing season. At the plant development stage, black gram needs 305 mm and green gram 762-1016 mm of rainfall. Although most pulses do not thrive well if the rainfall exceeds 1000 mm, green gram can fairly resist the effect of excess rainfall. If there is a heavy rain during the flowering period, pulses are subjected to diseases. As the growing period for pulses is relatively short, they can mature before the soil is too dry. The late monsoon rain is usually sufficient for pulses without irrigation water supply. However, the area's suitability for pulses is limited.

Temperature and Groundnut

At the initial stage of growth, groundnut needs a mean minimum temperature of 19˚C to 20˚C. In study area, the mean monthly temperature of November is 26.6˚C. Thus the temperatures of study area at initial stage are favorable for groundnut. At the development stage, the mean maximum temperature requirement is not less than 24˚C to 26˚C. At this period, Hlegu Township temperature is 24.2˚C. At the flowering stage, the optimum temperature requirement for groundnut is 22˚C to 26˚C. The township experiences a mean temperature of 24˚C. The period just before the harvest, the optimum temperature for groundnut is 25˚C. At this time, the study area receives 25.9˚C, higher than the optimum temperature. The condition of temperature is generally favorable for growing groundnut. See table 3.

Table 3 Growing period for groundnut (115) days (November to February)

Stages	Crop requirement		Actual condition		Soil moisture storage
	Temperature ˚C	Rainfall mm	Temperature ˚C	Rainfall mm	mm
Initial stage (Nov 1- 12)	19-20	100-225	26.6	65	217
Development stage(Nov10-Dec-10)	24-26	125-225	24.2	4	82
Flowering stage(Dec.11-Jan28)	22-26	125-225	24	-	-
Harvest stage (Jan 29-Feb23)	25	80-120	25.9	9	-

Source: Department of Agricultural Land Management and Statistics, Hlegu Township

Rainfall and Groundnut

The optimum amount of rainfall for groundnut during the whole growing period (November to February) is 400- 1000 mm. At the initial stage, rainfall requires 100-225mm. At this period, township receives 65 mm of rainfall and soil moisture storage is 217 mm. The amount of the rainfall required at the development stage is 125-225mm. The township receives 4 mm of rainfall and 82 mm of soil moisture storage. The optimum rainfall for groundnut at the flowering stage is 125-225mm. The rainfall received at this period is almost nil and thus there is no soil moisture storage. At the mature and harvested stage, groundnut needs 80-120 mm. At that period, Hlegu receive 9 mm of rainfall and soil moisture storage is zero. (See table 3.) Excepting the initial stage, the amounts of rainfall received in Hlegu Township are not sufficient for groundnut.

Temperature and Sesame

Formerly, sesame is widely grown in Hlegu Township. Since recent year, it has been replaced by pulses because of more profit. The growing of winter sesame usually begins in October. At the initial stage, winter sesame needs a temperature of not less than 12˚C for seed germination and the optimum temperature for this stage is 25˚C. At this period, the study area receives 27.6˚C. The temperature of study area is higher than the optimum temperature, thus causing slow germination and growth. During the growth stage, temperature between 25˚C and 29˚C are the best condition for sesame. The township's mean maximumtemperature is 26.55˚C and thus sesame plants can be fully developed. The optimum temperature for sesame at the harvest stage is between 25˚C and 27˚C. At the harvest time or the end of growing period, the temperature of the township is 25.85˚C. So, the temperature condition of study area is suitable for sesame. (See table 4.)

Table 4 Growing period for Sesame (120) days (October to February)

Stages	Crop requirement (˚C)	Actual condition (Temperature ˚ C)
Initial stage (Oct 11-30)	25	27.6
Development stage (Oct 31-Nov.29)	25-29	26.55
Flowering stage (Nov.31-Jan -13)	4	23.95
Harvest stage (Jan 14- Feb7)	25-27	25.85

Source: Department of Agricultural Land Management and Statistics, Hlegu Township

Rainfall and Sesame

Sesame requires a total rainfall of 305-508 mm in the growing period. It needs 75- 150 mm of rainfall at the initial stage, 150-200 mm at the flowering stage and less than 120 mm at the harvest stage. The amount of rainfall received at the early phase is sufficient, but deficient at the later stage which demands irrigation water for optimum growth.

Temperature and Sunflower

Sunflower is grown in the winter. It grows well where the average temperature is between 20˚C to 24˚C within the whole growing period. In Hlegu, the growing of sunflower begins in November and the average mean temperature is 26.6˚C which is fairly higher for germination and growth. At the development stage, the sunflower needs temperature is 24.15˚C. At the flowering stage, the area receives an average mean temperature of 23.95˚C favourable for flower forming and seed fertilization. The harvest stage exceeds considerably the optimum level. With an average mean temperature of 28.5˚C higher than the optimum temperature, the resultant seeds have low content of oil and many are of the unfertilized ones. Therefore, the temperature of Hlegu Township is not well suited for sunflower.

Rainfall and Sunflower

Sunflower is one of the winter crops grown in Hlegu Township. The optimum rainfall requirement is 75- 135mm at the initial stage. At this period, the study area receives 65 mm of the rainfall and 217 mm of soil moisture storage. At the development stage, sunflower needs the rainfall of 160- 230 mm. At this period, the township has 4 mm of rainfall and soil moisture storage is 82 mm. Sunflower needs 190-315mm at the flowering stage and 75-120 at the mature and harvest stage. The rainfall received during this period in the study area cannot satisfy the need. If the rainfall is less than 70 mm at the growth stage, the plant growth will be affected severely. In the study area, the rainfall is sufficient for sunflower at the initial stage. As the later stage coincides with the dry period, extreme water storage often occurs resulting in retarding of plants and seeds without oil. Sunflower by nature demands more water than other winter crops. Rainfall requirement for the entire growing period is 500-600 mm. Sunflower in the study area is much restricted.

Day Length and Plant Growth

Inthe study area, the seasonal variation in day length is fairly small. The difference of day length between winter solstice and summer solstice is only 2.39 hours for the study area. Paddy prefers shorter day length. Different crops demand different day length for maximum growth. Paddy needs a day length of 10 to 14 hours in the entire growing period. As no month in the study area is less than 10 hours in day length, paddy is suitable crop in this township based on this climate parameter. Other major crops grown in this township, such as pulses, sesame and sunflower all demand day length of between 10 and 14 hours. The day length of study area is thus favourable for these crops and exerts no negative impact on them. Instead, it enhances maximum growth and good yield. Monthly day lengths with sunrise and sunset hours of Hlegu Township are shown in Table 5.

Table 5 Day length of Hlegu Township (hours)

Month	J	F	M	A	M	J	J	A	S	O	N	D
Sunrise	6.44	6.36	6.15	5.51	5.34	5.30	5.38	5.48	5.55	5.64	6.07	6.34
Sunset	17.49	17.66	18.18	18.26	18.38	18.48	18.48	18.40	18.11	17.48	17.32	17.31
Day length duration	11.05	11.30	12.03	12.35	13.04	13.18	13.10	12.52	12.16	11.44	11.25	10.39

Source: Meteorology and Hydrology Department, Yangon

Humidity and Plant Growth

Relative Humidity is not one of the most important climatic factors, but the extreme conditions can cause negative effects to the crop growth. If relative humidity exceeds 65 percent, most crops are susceptible to infection; though its effect may be negligible. Paddy is the major crop of the monsoon period when the percentage of relative humidity ranges between

80 and 89. Thus, paddy plants are liable to fungus infection. Nevertheless, paddy can naturally resist the infection and damage is negligible. The winter crops are more suited to the atmospheric humidity of the Township. In December, the township experiences a mean monthly relative humidity of 71 percent and thus it is fairly favourable for the crops at the development stage. The distribution of relative humidity of the study area isalso favourable for the cultivation of winter crops.

Conclusion

The study area being located in the north-eastern part of Yangon Region has locational advantage. It is easily accessible by the Yangon- Bago highway, and the presence of broad lowlying plain is also because of its location. Physiologically about four-fifth of the area is generally flat with elevation less than 100 feet above see-level. The lowland is favourable for field crops cultivation and upland area for perennial crops cultivation and forests. Having tropical monsoon climate, the temperatures are high throughout the year and thus the cultivation of crop is not restricted by this agro-climatic factor. Even in the coolest period the temperatures remain above 21˚ C and hence it does not affect the plant growth. The annual rainfall of the township is 2518 mm. Except for a few months in the dry period; relative humidity is high, usually about 70 percent, and around 90 percent in the peak-monsoon period. High percentage of relative humidity is not desirable for paddy and other field crops as it induces the occurrence of plants diseases and pestilence. The normal wind speed in all seasons exerts no adverse effect on plants. However, occasional squall in the monsoon period and the high velocity of east wind in the winter sometimes can be destructive to the crops growth including perennial trees. The analysis of crop-climate relationship shows that the township enjoys sufficient temperatures even in the cool season. There is excess of water in the peak monsoon period and thus more drain lines should be dug to drain off the excess water. In the dry season, soil moisture storage shows negative and the soils are too dry for crops cultivation. This increases the need for irrigation water for most crops. The study area is well suited for paddy plants.The condition of temperature is generally favorable for growing groundnut and sesame.However, the area suitable for pulses is limited. The temperature and rainfall of Hlegu Township are not well suited for sunflower. The day length of study area is thus favourable for these crops and exerts no negative impact on them. The relative humidity of the study area also is favourable for the cultivation of winter crops.

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လယ်ယာစိုက်ပျိုးရေးဝန်ကြီးဌာန။ မြန်မာစိုက်ပျိုးရေးလုပ်ငန်း၊ မျိုးစေ့ဌာနခွဲ(နှံစား၊ပဲမျိုးစုံ၊ဆီထွက်သီးနှံ)။

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