

ANALYSIS ON SPATIAL DISTRIBUTION OF FIRE STATIONS IN CHANAYETHAZAN TOWNSHIP

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Abstract

This research attempts to analyze the spatial distribution of fire stations in Chanayethazan Township. The main aim of this research is to evaluate whether the number of fire stations are sufficient for the protection of the outbreaks of the fire or not in the wards of the Chanayethazan Township. The spatial distribution of fire stations are analyzed by using Hot Spot Analysis adopted by Getis-Ord Getis and Multi Ring Buffer with the aid of Geographic Information System (GIS). It is found that the housing types and inadequate water are important for fire prevention in the township. Seittaramahi, Thirihaymar (West), Pyigyipyawpwe (West), Dewun (West) are danger zones with fire precaution because of the largest number of houses, unsystematic road system and inflammable materials. To avoid the fire outbreaks, systematic utilization of land is essential in Chanayethazan Township.

Keywords: outbreaks, Hot Spot Analysis, Multi Ring Buffer, prevention, precaution, inflammable materials

Introduction

The study area, Chanayethazan Township lies in the Mandalay City (Mandalay Region), of Myanmar (Map.1). In Mandalay the physical factors concerning high temperature, dry climate and inadequate water may cause fire in the same way. The human factors such as dense population and narrow street can cause fire. The hottest months which are March, April and May are the months with the most fire hazard. Chanayethazan Township lies within the boundary of the fire hazard area.

According to 2017 data, there were totally, 3 fire outbreaks with a total loss of about 99,000,000 kyats in Chanayethazan Township. The number of fire and the losses are varying with the type of fire outbreaks and localities. The cause of fire were found electric fire, to be careless disposals of cigarettes and smokers after smoking, careless offering of incense sticks to the Buddha Images, playing of children and mad persons with fire, burning of fire by destructive persons and overheating in ironing clothes. That is why prevention of the fire outbreak plays an important role for the people in Chanayethazan Township. As fire can causes the loss of public and private properties, cultural heritages and the lives of the people, it is necessary to prevent the occurrence of fire.

This paper is a research working on the danger of fire to analyze the spatial distribution of fire stations and to evaluate their efficiency for the number of houses and residents.

Aim

The main aim of this research is to evaluate whether the number of the fire stations are sufficient for the protection of the outbreaks of the fire or not in the wards of Chanayethazan Township.

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Objectives

- to set up fire stations in respective wards
- to study the spatial distribution of fire stations within the township
- to describe the availability of water within the study area
- to calculate the place of township's central fire station (Mean Centre) with GIS method and
- to analyze the relationship between fire stations and building in the study area

Study Area

Chanayethazan Township lies within the Mandalay City of Central Dry Zone in Myanmar and between north latitudes 21° 58' 2.51" and 21° 59' 5.02" and between east longitudes 96°3' 10.16" and 96°7' 59.57". Chanayethazan Township is bounded by Aungmyethazan Township on the north, by Patheingyi Township on the east, by Mahaangmye Township on the south and by Sagaing Township on the west by the Ayeyarwady River.

Chanayethazan Township has an area of 5.054 square miles. The township extends 5.85 miles in east-west and 0.92 mile in north-south. As it is narrow from north to south direction and long from east to west direction, it has a rectangular shape. The township is constituted with 20 wards shown by Map (1) and Table (1). Chanayethazan township lies on the Ayeyarwady River terrace, which has the flat surface. The highest place is 245 feet above sea level and the lowest place is only 220 feet above sea level. **Thingaza Creek** extends in north-south in the western part of the Chanayethazan Township and is a natural drainage one. **Shwetachaung Canal** is higher in discharge than other canals and is more effective than other canals. **Yenimyaung** is one of the distributary canal of Myaungmagyi Canal which receives irrigated water from the Sedawgyi Dam. **Mahanadi Canal** drains through Kankauk Ward in the north-south direction. **Myoma Canal** (Colombo Canal) is the main sewage canal or drain in carrying the waste materials for the Wards of the eastern part of Mandalay.

Chanayethazan Township is located in the Dry Zone of Central Myanmar and hence it has generally high temperature throughout the year. The township has a scanty rainfall and dry climate due to the following: it is an inland area far from the sea, it is a low-lying area, between mountain ranges, open to the south. During the 26-year period of 1991-2016, the average mean temperature was 82.46°F. The average maximum and minimum temperature were 92.95°F and 71.75°F, respectively. April is the hottest month and the coldest month is January. The average rainfall is 36.29 inches. September has the highest rainfall and January is the lowest rainfall. According to Koppen's classification of climates, Mandalay including Chanayethazan Township experiences the Tropical Savanna Climate (Aw).

In 2017 population has increased to 148,240 persons. Thus, it is known that population of the township has increased at an annual growth rate of 0.33 per cent during the 2013-2017 years.

Table (1) Population and Population Density of Chanayethazan Township (2017)

No.	Ward Name	Area in square mile	Total Population	Population Density per square mile
1	Pyigyimyethman	0.392	4,555	11,621
2	Pyigyimyetshin	0.422	10,600	25,140
3	Patkonyawbwe	0.308	4,850	15,738
4	Yanmyolon	0.197	6,651	33,729
5	Patkonwunkyin	0.156	4,277	27,494

No.	Ward Name	Area in square mile	Total Population	Population Density per square mile
6	Seittaramahi	0.174	6,314	36,193
7	Mawragiwa	0.209	10,907	52,230
8	Kinsanamahi	0.280	9,378	33,491
9	Haymazala	0.211	7,508	35,536
10	Chanayethazan (East)	0.112	4,740	42,262
11	Chanayethazan (Middle)	0.112	4,912	43,827
12	Chanayethazan (West)	0.089	1,019	11,474
13	Aungnanyeiktha (East)	0.276	9,621	34,920
14	Aungnanyeiktha (West)	0.194	7,641	39,330
15	Thirihaymar (East)	0.154	3,582	23,314
16	Thirihaymar (West)	0.178	7,676	41,934
17	Pyigyipyawpwe (East)	0.109	5,197	47,631
18	Pyigyipyawpwe (West)	0.229	15,404	67,386
19	Dewun (West)	0.247	9,817	39,687
20	Kankauk	1.005	13,791	13,727
	Total	5.054	148,240	29,331

Source: Immigration and National Registration Department, Chanayethazan Township

Availability of water, population, buildings and types of economic activities, structure of road networks are critical factors in preventing the danger of fire. Seittaramahi, Thirihaymar (West), Pyigyipyawpwe (West), Dewun (West) are particularly susceptible for breaking out of fire and their dangers. Kankauk Ward has the largest number of houses and household due to the state policy and changes in urban land use. Moreover, there are many rental houses who live there to perform various businesses in the surrounding areas of jade-market. The rental houses are built of easily inflammable building materials such as bamboo and timber. The majority of the residents are carried out in primary activities such as add-jobs, wage earners. This is the major reason for easy occurrence and danger of fire.

This ward is installed only a few number of extinguishing tugs and tanks. Although the Shwetachaung canal and the Thingazare creek are located as water sources in this ward, street structure is so poor with narrow lanes causing difficulties in movement of the extinguishing vehicles. Therefore, there are weaknesses in prevention of fire in this area.

In Dewun (West), the state policy of shifting people from the huts to the apartment is a prevention of fire. However, the remaining portions of the ward are settled with easily inflammable houses made by bamboo mats crowdedly while the streets are narrow and water supply is uneven. Therefore, it is the most dangerous place for the outbreaks of fire in the township.

For these reasons there are many possibilities for outbreaks of fire in Chanayethazan Township and it is necessary to carry out systematic management for the prevention of the fire outbreaks.

Data Collection and Methodology

In this research, the necessary data and materials are collected by the field survey. The secondary data and the necessary map are collected from the concerning offices. In order to examine the spatial distribution of fire stations Hot Spot Analysis and Multi Ring Buffer

methods are used. Geographical interpretations of the results have been done with the help of the maps.

Distribution of Fire Stations in Chanayethazan Township

A natural disaster of fire outbreaks can cause losses of human lives, and properties. The danger for breaking out of fire cannot be predictable and for that reason, prevention measure can effectively prevent the loss of fire. In order to solve the problem of fire hazard, the township Fire Department was established. Moreover, there is one Fire Brigade Squadron in every ward of the township. (Map.2)

There are totally 15 fire stations in Chanayethazan Township including the Central Fire Station of which one fire stations is allocated Chanayethazan (East) Ward. Fire Brigade Department has 27 extinguishing vehicles, 2 CCTV and 3 ambulance. The Man Power of Fire Brigade Department is composed of 496 Auxiliary Firemen (AFM) and Fireman.

When the availability of water for fire extinguishing vehicles, there are extinguishing tugs, tanks and canals in this wards. There are 235 extinguishing tugs, 42 tanks, two natural ponds, and five canals. Moreover, the Thingaza creek and the Shwetachaung canal in this township also provide water resources for availability of water to extinguish fire.

The distribution of the extinguishing tugs and tanks varies from one ward to another in Chanayethazan Township. The largest number of extinguishing tugs are found in Aungnanyeiktha (East) Ward while Pyigyimyethsin, Aungnanyeiktha (West), and Dewun (West) are installed with the least number of tugs. The installation of the extinguishing tugs and tank for fire stations varies with the number of houses and households in the wards. This uneven distribution of the tugs and tanks is a weakness in fire prevention work. It is found that, however, some wards have not only the sufficient number of tugs and tanks but these wards also have easy access to the natural ponds and water bodies see Table (2) for the spatial distribution of fire stations, vehicles, extinguishing tugs and tanks in Chanayethazan Township.

A fire station in Chanayethazan Township has been supplied with one or two vehicles to prevent the danger of fire in advance. Moreover, the vehicles with the capacity to carry 450 gallons, 700 gallons, 800 gallons, 1200 gallons and 1500 gallons of water are provided to the fire stations. In Mandalay City, necessary water for extinguishing vehicles is distributed by No (3) pumping station, No(3) Malun ward in Chanayethazan Township, Nyaungwe pumping station No.4 in Aungmyethazan Township and No.2 water pumping station in Chanayethazan Township.

Among the various types of extinguishing vehicles 450 gallons capacity vehicles can serve only about 2 minutes in cases of fire while 1500 gallon capacity vehicles can extinguish fire only about 7 minutes. As the water runs out while extinguishing fire, the necessary water is supplied with subordination or shuttle system by means of light machines and assistant vehicles from water sources. As a result it is an important requirement for the wards to be supplied with and installed with extinguishing tugs and tanks. Besides, it is also equally important to maintain the tugs and tanks from damages. For this reason, easy access the source of water is a critical factor in danger of fire.

Table (2) The Factors with Fire Stations in Chanayethazan Township

No.	Ward	AFM/ FM	Building	Fire Truck/ Ambulance/ CCTV	Tanks	Tugs	Fire Stations
1	Pyigyimyethman	-	1,412	-	-	8	-

No.	Ward	AFM/ FM	Building	Fire Truck/ Ambulance/ CCTV	Tanks	Tugs	Fire Stations
2	Pyigyimyetshin	35	2,589	2	-	7	1
3	Patkonyawbwe	-	1,448	-	-	-	-
4	Yanmyolon	35/1	1,680	2	1	9	2
5	Patkonwunkyin	35	1,358	1/-/1	-	10	1
6	Seittaramahi	-	1,168	-	1	11	-
7	Mawragiwa	35	933	1	8	14	1
8	Kinsanamahi	35	961	1	-	19	1
9	Haymazala	-	417	-	2	9	-
10	Chanayethazan (East)	40	561	8	-	22	1
11	Chanayethazan (Middle)	-	407	-	-	26	-
12	Chanayethazan (West)	35	388	2/1/1	1	11	1
13	Aungnanyeiktha (East)	35	1,657	1	3	39	1
14	Aungnanyeiktha (West)	35	1,299	1	3	7	1
15	Thirihaymar (East)	35	580	1	3	15	1
16	Thirihaymar (West)	35	1,196	2/1	10	10	1
17	Pyigyipyawpwe (East)	35	1,277	2/1	3	12	1
18	Pyigyipyawpwe (West)	35	1021	2	4	-	1
19	Dewun (West)	35	1,137	1	3	6	1
20	Kankauk	-	2,038	-	-	-	-
	Total	496	23,527	27/3/2	42	235	15

Source: Fire Brigade Department in Chanayethazan Township

Spatial Analysis of fire Stations

Management for the control and prevention of fire is depending on the existence of the fire stations, availability of water and the capability of the Fire Brigade Department. Therefore, spatial distribution of fire stations is studied to examine the effectiveness of fire preventive measures. This research paper is carried out with Hot Spot Analysis and Multi Ring Buffer methods. First of all, the mean center for the location of fire stations is determined for Chanayethazan Township. It is found that in Mawragiwa Ward. It is also that probability of fire outbreak varies with the distance from the central area-the lowest probability in the nearest areas and the highest probability in the furthest areas.

When the distribution of fire stations is examined with building weighted value, it is found that Thirihaymar (East), Pyigyipyawpwe (West), Pyigyipyawpwe (East), Thirihaymar (West), and Dewun (West) are the areas with the least prevention for the danger of fire, and Yanmyolon, Pyigyimyetshin, and Patkonwunkyin are the areas with sufficient prevention for the danger of fire. Map (3).

The fire stations in Chanayethazan (East), Chanayethazan (West), Aungnanyeiktha (East), Mawragiwa, and Aungnanyeiktha (West) wards can provide sufficient prevention for the danger of fire.

When the distribution of fire stations are examined by means of Multi Ring Buffer method, it is found that there are 2 fire stations in the 500 meter radius from the mean center, 3 fire stations in the 1,000 meter radius, 2 fire stations in the 1,500 meter radius, 2 fire stations in the 2,000 meters radius, 3 fire stations 2,500 meter radius and 3 fire stations in the remaining radius from the mean center of Chanayethazan Township. Therefore, the number of the fire stations is the largest in 500-1,000 meter distance from the mean center and the danger of fire can be effectively prevented in this zone. It is found that the areas with efficient fire stations include Yanmyolon, Patkonwunkyin, Mawragiwa and Kinsanamahi wards. The areas which lie in 2,500 meter buffer zone are Thirihaymar (East), Pyigyipyawpwe (West), Pyigyipyawpwe (East), and Thirihaymar (West) while Dewun (West) ward lies outside 2,500 meter buffer zone from the mean center Map (4).

Therefore, it is found that the areas close to the mean center with fire station can obtain sufficient protection from the danger of the fire.

Conclusion

Availability of water, sufficient road width, the housing structure, population, economic activities and governmental policies are play a critical role in the study of spatial distribution of the fire stations and effectiveness of fire preventive measures.

Outbreaks of fire can be effectively controlled when there is availability of sufficient water, systematic street structure and good socio-economic conditions, and the prevention of fire has to meet with the problems when there is difficulty in availability of water, poor road structure and poor housing structure of low income earning people. Governmental policy particularly plays an important role in allocation of the fire stations for fire prevention and control. There are 7 wards, with sufficient number of fire stations and 6 wards with moderately sufficient fire station and 7 wards with the least prevention by the fire stations.

Therefore, it is necessary to open new fire stations in the least fire prevented wards, especially in Pyigyimyethman, Patkonpyawbwe, Seittaramahi, Haymazala, Chanayethazan (Middle), and Kankauk are suffered from the largest number of fire. It is also necessary to open new fire stations in Dewun (West) which lies the furthest from the mean center of Chanayethazan Township.

Moreover, new extinguishing tank should be installed in Pyigyimyethman, Pyigyimyethshin, Patkonyawbwe, Patkonwunkyin, Kinsanamahi, Chanayethazan (East), Chanayethazan (Middle), and Kankauk where there are low number of the extinguishing tanks. The tugs should be installed Patkonyawbwe, Pyigyipyawpwe (West), and Kankauk. The road-types should be systematically managed in the wards for easy movement of the vehicles for the fire preventive measures.

If the above problems can solve, the township would become more developed and will be advance in modern urban centre of the city. The people of Chanayethazan Township can live peacefully and securely away from the danger of natural disasters.

Suggestions

1. To systematically set-up roads and buildings within the study area
2. To sufficient water within the study area
3. To upgrade the quality of fire stations and members of fire brigade in the present condition
4. To alert the danger of fire outbreak among the people

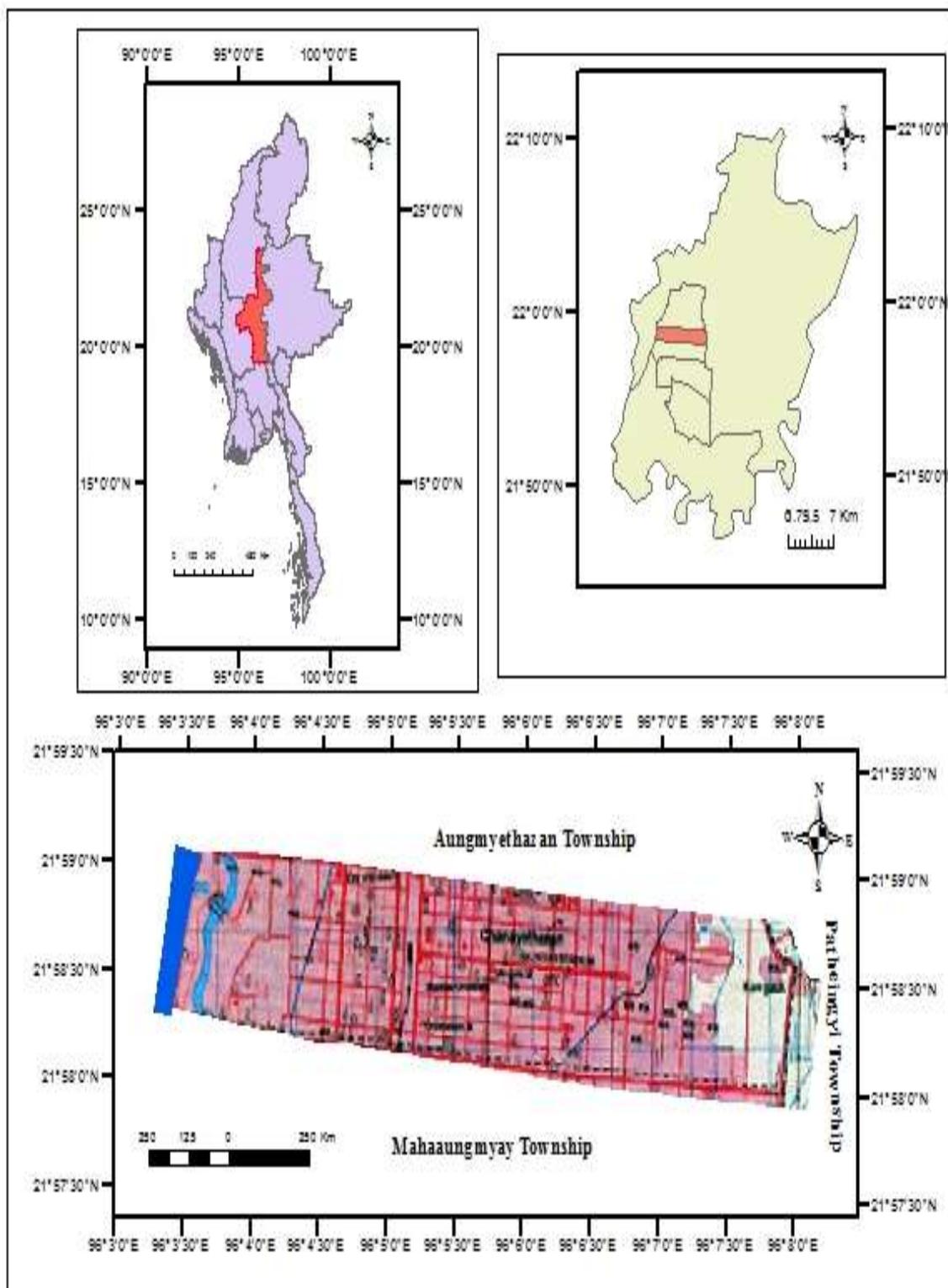
Acknowledgements

First of all, we would like to express our heartfelt gratitude to Dr Maung Maung Naing, Rector, Dr Si Si Khin, Pro-rector and Dr Tint Moe Thuzar, Pro-rector, Yadanabon University for their permission to carry out this research work and their encouragement. We are greatly indebted to Dr. Khin Thein Oo, Professor and Head of Department of Geography and Dr Khin Win, Professor, Department of Geography, Yadanabon University for their exhortation and helpful comments on this research. Lastly, this work is dedicated to all our teachers and colleagues who have helped out with great kindness and patience.

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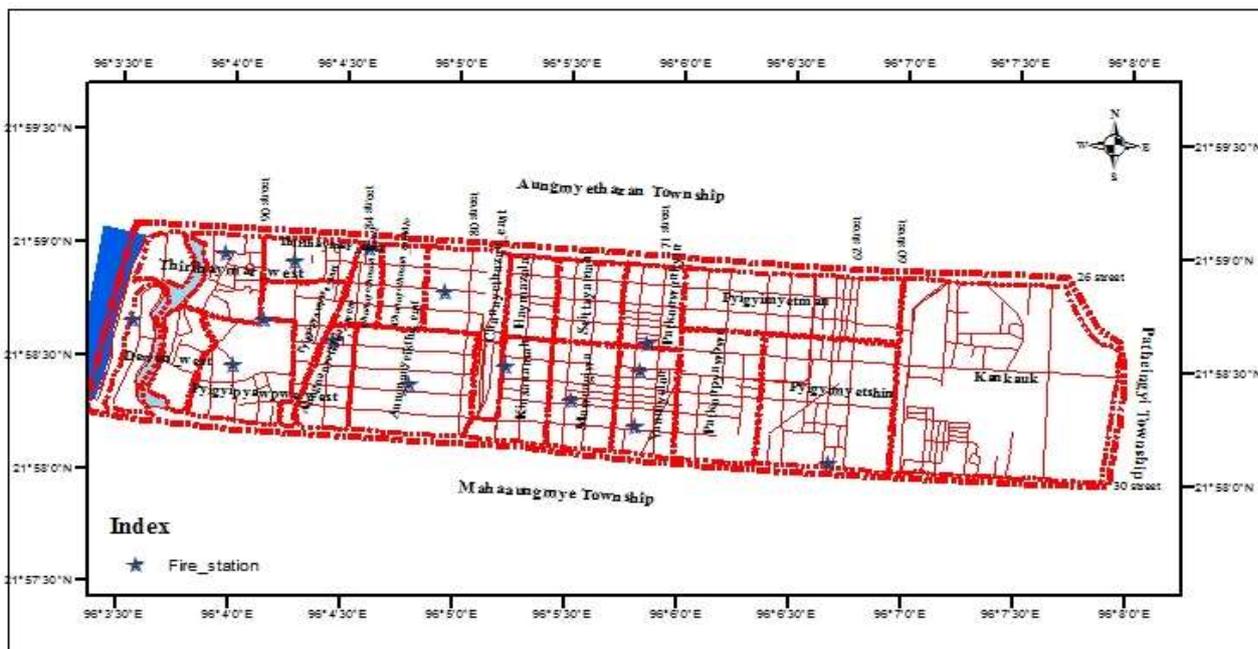
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MAP (1) LOCATION OF CHANAYETHAZAN TOWNSHIP



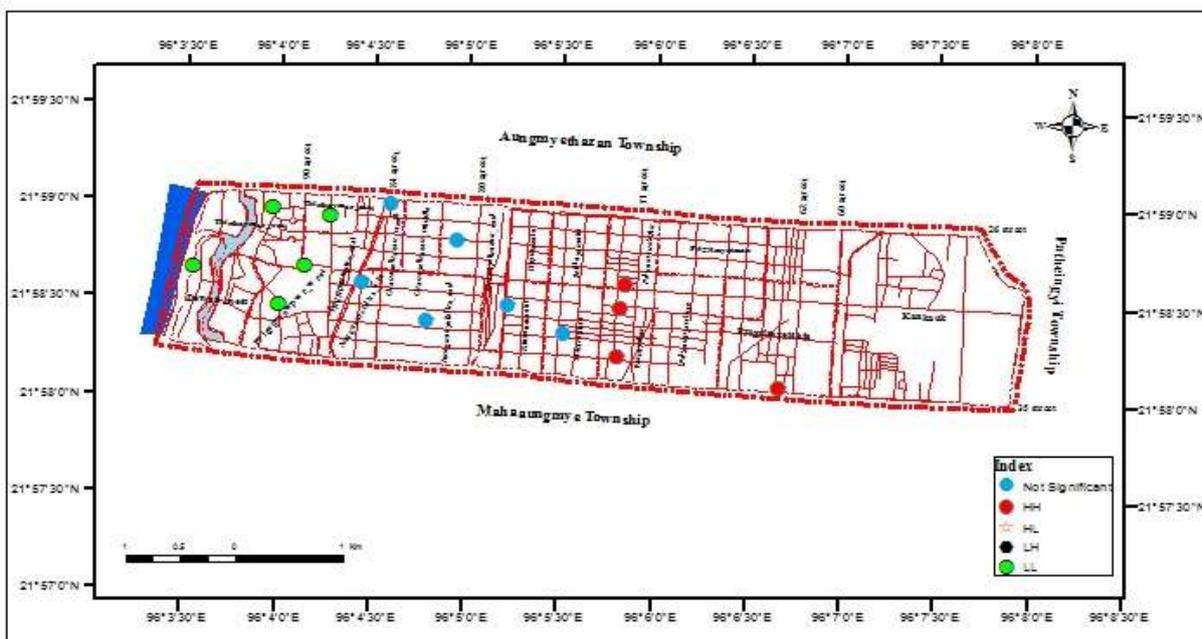
Source: UTM Map (WGS 1984)

MAP (2) SPATIAL DISTRIBUTION OF FIRE STATIONS IN CHANAYETHAZAN TOWNSHIP



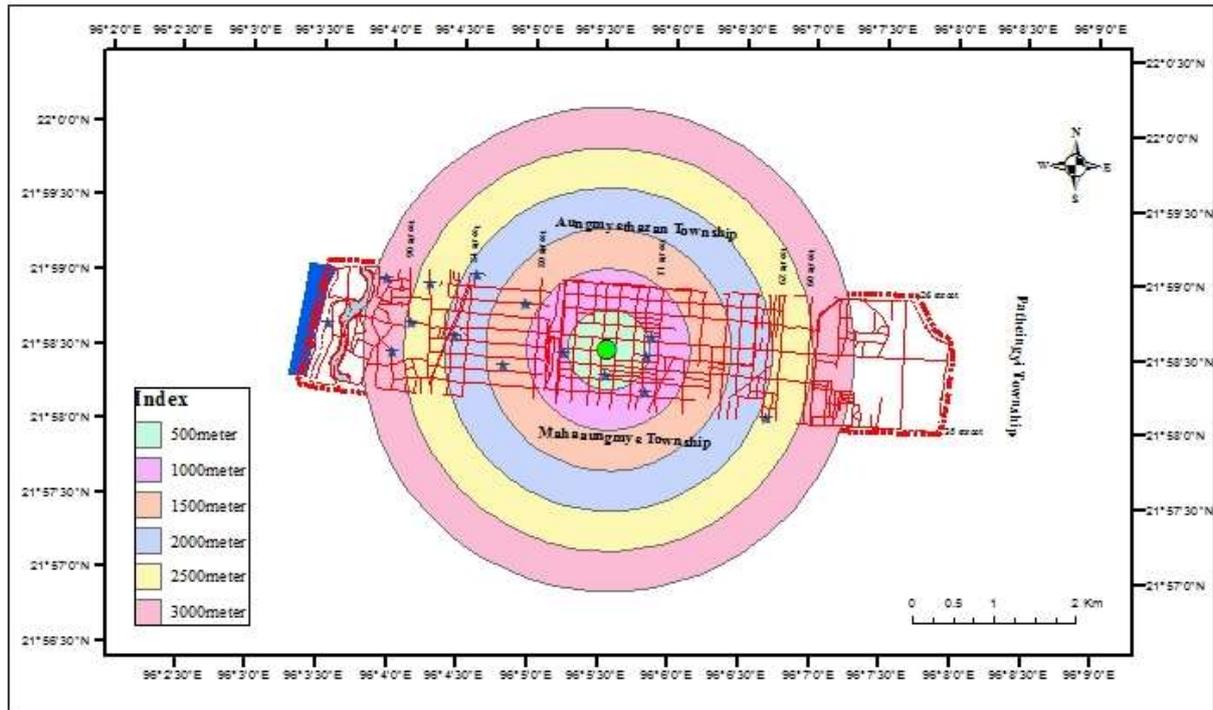
Source: Calculated by GIS (WGS 1984)

MAP (3) THE RELATIONSHIP BETWEEN FIRESTATIONS AND BUILDING IN CHANAYETHAZAN TOWNSHIP



Source: Calculated by The Researcher, Field Survey

MAP (4) SPATIAL DISTRIBUTION OF FIRE STATIONS IN CHANAYETHAZAN TOWNSHIP BY USING MULTI RING BUFFER



Source: Calculated by The Researcher, Field Survey