

Spatial Distribution of Fire Stations in Aungmyethazan Township

Than Than Myint*, Hla Kyi**, Myint Myint Sein***, Thein Htoo****, Cherry Win,*****,
Kyι Khaing*****

Abstract

This study focuses on "Spatial Distribution of Fire Stations in Aungmyethazan Township". The main aim of this research is to evaluate the fire safety, prevention and rescue for natural disaster of fire risk in Aungmyethazan Township. In order to examine the spatial distribution of fire stations, a Cluster and Outlier Analysis are conducted by Anselin Local Morans I and Multi Ring Buffer Method with the aid of Geographic Information System (GIS). It is found that major factors affecting on out breaks of fire and that spatial variation of fire stations plays a major role of fire safety in the township. In Aungnyethazan Township, Thirimarlar-East, Thirimarlar-West, Palengweyaung, Pyigyikyethayay-East wards are particularly vulnerable for breaking out of fire. The danger- zones needed to make fire precaution because the largest number of houses, narrow and congested road networks and inflammable materials are found there. For the fire safety the expansion of roads and streets, the good accessibility for the fire extinguishers and supplying of adequate water are essential in Aungmyethazan Township.

Key words: outbreaks, Cluster and Outlier Analysis, Multi Ring Buffer, prevention, precaution, inflammable materials.

Introduction

A natural disaster of fire outbreaks can cause losses of human lives and properties. The danger for breaking out to fire cannot be predictable and for that reason, prevention measure can effectively prevent the losses of fire. In order to solve the problem of fire hazard, Myanmar Fire Force formed with Fire Services Department personnel. In this expression, auxiliary fire brigade and reserve fire brigade are also included. Generally, fire station is a structure or area for storing firefighting apparatus such as fire engines and related vehicles, personal protective equipment, fire hoses and other specialized equipment. Firefighters also provide an important role in educating the public regarding fire and safety. According to Williams by teaching fire prevention and educating the public on how to respond in emergency situations, they can help save lives.

The study area, Aungmyethazan Township lies in the Mandalay city (Mandalay Region) of central Myanmar. (Map.1). Physical factors of Mandalay City can cause fire hazard. There is inadequate water, high temperature and scarcity of natural vegetation. In addition, the social

* Associate Professor, Dr, Department of Geography, Yandanabon University

** Associate Professor, Dr, Department of Geography, Yandanabon University

*** Associate Professor, Dr, Department of Geography, Yandanabon University

**** Associate Professor, Dr, Department of Geography, Yandanabon University

***** Lecturer, Dr, Department of Geography, Yandanabon University

***** Lecturer, Dr, Department of Geography, Yandanabon University

factors such as thick population, buildings, economic activities and structure of networks are critical factors in preventing the danger of fire. In Aungmyethazan Township, the outbreak of fire is usually during summer. Throughout the year, March April and May are the hottest month with the most fire hazard. This research paper is a work on the danger of fire and aims to analyze the spatial distribution of fire station and to evaluate whether the number of the fire stations is sufficient for the protection of the outbreaks of the fire or not in the wards of Aungmyethazan Township.

Aim and objectives

The main aim of this research is to evaluate the fire safety, prevention, search and rescue of natural disaster of Aungmyethazan Township. This research paper is also intended to highlight the following four major objectives and they are

1. to trace the major factors that affect on outbreak of fire in Aungmyethazan Township.
2. to study the availability of water within the study area
3. to present the spatial distribution of fire stations in the study area.
4. to analyze the relationship between fire stations and buildings in the study area.

Study Area

Aungmyethazan Township is one of the 7 townships in Mandalay City. It is located in the northern most part of the Greater Mandalay. The township lies north of Bayintnaung Road (26th street) running east-west and is situated between latitude 21°51' 48" North and 22°01'30" North and between longitudes 96°03'42" East and 96°07' 57" East. Aungmyethazan Township is bounded on the northwest, north and east by Patheingyi Township for about 7.2 miles, on the south by Chanayethazan Township for about 4.43 miles, and on the west by the Ayeyarwady River for 2.2 miles. The township has an area of 7058 acres or 11.02 square miles, about 23.14 percent of the Mandalay city area, and is the largest one among those of seven Mandalay Township. In general, the township has a rectangular shape extending east west for 4.38 miles and north-south for 2.94 miles. Aungmyethazan Township comprises 19 wards with 277 sub quarters including the old palace area existing as cantonment area of present. There are Pyigyikyethayay -East, pyigyikyethayay-West, Minde Ekin, Aungmyethazan, Palengweyaung, Maygagiri, Pylonchaitha, Pyigyianlon, Amara-htani-West, Amarahtani-East, Nyaunggwe, Obo, Uboketaw, Phonedawtoe, Dawnabwar, Ahnaketaw and Mahazayarbon wards. Uboketaw is the largest ward with 3.91 square miles of area whereas Pyigyikyethayay -East ward is the smallest ward with 0.08 square miles. (Map1) and (Table 1)

Aungmyethazan 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 215 feet above sea level. There are two distinct drainage patterns in Aungmyethazan Township: one is the artificial pattern which is composed of the canals namely Shwetachaung, Mahanadi, Ngwetachaung, Tetmyaw, Shwekyinchaung and of water-supply canal to the moat whereas the natural one consists of the Ayeyarwady River and Thingazar stream.

Aungmyethazan 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 30-year period of 1990–2019, the average mean temperature is 82.3°F. The average maximum and minimum temperature are 92.8°F and 71.8°F, respectively. April is the hottest month and the coldest month is January. The average rainfall is 36.6 inches. September has the highest rainfall and January is the lowest rainfall. According to Koppen’s classification of climates, Mandalay including Aungmyethazan Township experiences the Tropical Savanna Climate (Aw).

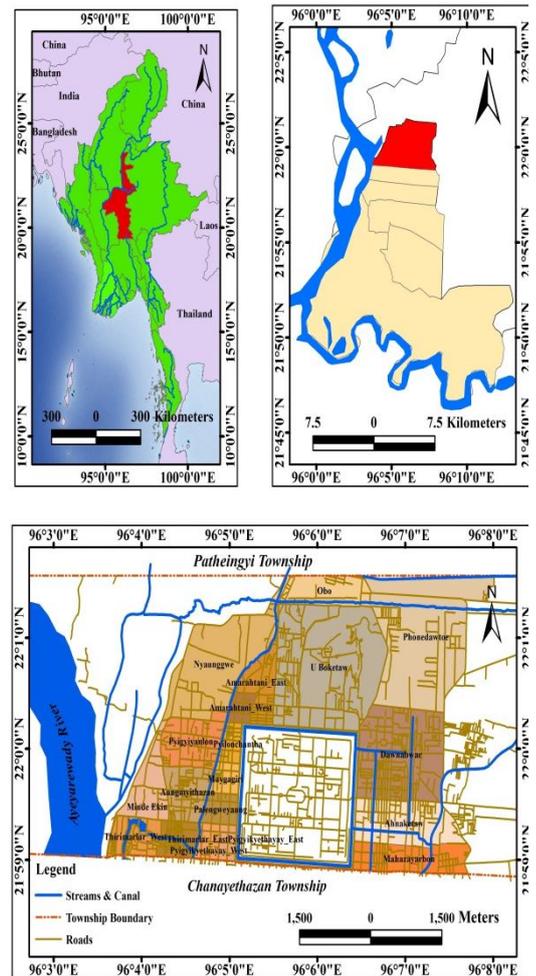
According to 2019 data, total population of the township is 291,996 persons and 297, 98 houses hold. The largest population is found in Uboketaw ward with 34,417 persons and the smallest population is found in Pyigyikyethayay–East ward with 3,091 persons. (Table 1)

Table (1) Population and Population Density of Aungmyethazan Township (2019)

No	Ward Name	Area in square mile	Total Population	Population Density per square mile
1	Pyigyikyetthaya y-East	0.08	3,091	38,637
2	Pyigyikyetthaya y-West	0.1	7,712	77,120
3	Thirimarlar-East	0.18	13,288	73,822
4	Thirimarlar-West	0.22	14,772	67,145
5	Minde Ekin	0.99	28,335	28,612
6	Aungmyethazan	0.37	14,359	38,808
7	Palenyweyaung	0.14	9,818	70,128
8	Maygagiri	0.27	7,045	26,092
9	Pyilonechantha	0.11	8,911	81,009
10	Pyigyianlon	0.11	1,9817	180,154
11	Amarahntani-West	0.05	6,406	128,120
12	Amarahntani-East	0.35	19,688	56,251
13	Nyaunggwe	0.3	28,951	96,503
14	Obo	0.34	15,422	45,411
15	Uboketaw	3.91	34,417	8,802
16	Phonedawtoe	1.64	7,941	4,842
17	Dawnabwar	0.13	28,765	22,126
18	Ahnaketaw	1.53	13,308	8,698
19	Mahazayarbon	0.17	9,950	58,529
	Total	11.02	291,996	26,496

Source: Immigration and National Registration Department, Aungmyethazan Township

Map (1) Location of Aungmyethazan Township



Source: UTM Map (WGS 1984)

Data collection and Methodology

Data used in this research paper were collected from both primary and secondary sources. In collection primary data, field observation is used by means of questionnaire survey, interview and informal talks with local people and governmental personal secondary data were derived from various departments' libraries, topographic maps and township records.

In this research paper, measurement is made by using quantitative and qualitative methods. As a quantitative analysis, the method is used to determine the spatial distribution of fire station in Aungmyethazan Township. In order to examine the spatial distribution of fire station, a Cluster and Outlier Analysis are conducted by Anselin Local Morans I and Multi Ring Buffer Method with the aid of Geographic Information System (GIS).

Major Factors that Affect the Outbreak of Fire in Aungmyethazan Township

The major causes of fire are found to be case careless disposals of cigarettes and cheroots after smoking, careless offering of incense sticks to the Buddha images, playing of children and mad persons with fire, burnings of fires by destructive person and overheating in ironing clothes. That is why prevention of the fire outbreak plays an important role for the people in Aungmyethazan Township. As fire breakout can cause the loss of public and private properties, cultural heritage and the lives of the people, it is necessary to prevent the occurrence of fires.

Major factors in preventing the danger of fire are availability of water, population, buildings and types of economic activities, structure of road network. According to 2019 data, these were totally, 11 fires out breaks with a total loss of about 50,920,950 kyats in Aungmyethazan Township. The number of fire and losses vary with types of fire outbreak and localities. During 2019, the largest loss of property by fire broke out in Amarahtani-East ward with 26,750,000 kyats which was followed by the loss of 14,600,000 kyats in Obo ward. The smallest property loss by fire was recorded in Thirimarlar-west ward with only 3000 kyats. During 2019, the spatial variation of fire outbreaks occurred three times in Dawnabwar ward, two times in Aungmyethazan ward and one time each in Thirimarlar-west, Pyigyianlon, Amarahtani-East, Obo, Uboketaw ward, Ahnaketaw ward respectively.

According to Aungmyethazan Township Fire Department, Aungnyethazan Township, Thirimarlar-East, Minde-Ekin, Aungmyethazan, Amarahtani-East, Obo, Uboketaw and Dawnabwar wards are particularly susceptible for breaking out of fire and their dangers zones with fire precaution because of the largest number of houses, unsystematically road networks and inflammable building materials.

Minde-Ekin ward has the largest number of houses and household due to the largest population with crowded population in the blocks. Moreover, there are many rental houses which are built to perform varies business in the ward. These rental houses are built of easily inflammable building materials pose the danger of fire problem. Although the shwetachung canal and Thingaza creek and Ayeyarwady River are located as water sources in this ward, street structure is so poor with narrow lanes causing difficulties in to movement of the

extinguishing vehicles. Therefore, it is the most dangerous place for the outbreak of fire in the township.

Thirimarlar-East had experienced the out breaks of fire of Nyaungbin zay in 1235 (ME) and the Mandalay conflagration in 1326 (ME). It is noteworthy that a lot of fire broke out in Mandalay city during the British colonel period. The biggest fire of Myanmar broke out in Mandalay on May 10, 1981, which begun in Thirimarlar-East ward covering a street of an area from 25th street to the north 13th street. Also in the fire of Ukyarkyi Win on March 24, 1984, the township was also again under the on slaught of the great fire in April 12, 1996, a fire broke out in Thirimarlar-East. The above mentioned fires are of great ones in preparation that rocks and shocks the whole country. Such fires of great are account owing to a host of cause, such as the high possibility of breaking out of fires in the hot summer, the existence of the inflammable hot summer, the existence of the inflammable hutments, lack of systematically built water tanks for fire extinguishing, the occurrence of the storage of water in summer, due to narrowness of roads and street and so on. Therefore, these are weaknesses in prevention of fire in this area.

The houses are densely located in Dawnabwar due to the changes in urban land use. Moreover, many rental houses are built of easily inflammable house made of bamboo mats crowdedly while the streets are narrow and water supply is uneven. Gas factory and the settlement of majority logic strata social class are also the major reason for easy occurrence and dangers of fire.

Amarahntani-East ward, there are many rental house who live there to perform various business in the surrounding areas of Sayasan market. These rental houses are built of easily inflammable building materials such as bamboo and timber. The street structure is so poor with narrow lanes causing difficulties in movement of the extinguishing vehicles are also the major reason for easy occurrence of dangers of fire.

The houses and households are densely located in Obo, Aungmyethazan and Uboketaw wards, the street structure is not systematized, tenant households use fire carelessly and availability of water is difficult so that there are also dangerous places in cases of fire.

Distribution of Fire Stations in Aungmyethazan Township

In order to prevent destruction of state owned property, private property, cultural heritage and the lives and property of the public by fire and other natural disaster, Aungmyethazan Township Fire Department was established. Moreover, there is one fire brigade squad in every ward of the Aungmyethazan Township. (Map. 2)

There are totally 16 fire stations in Aungmyethazan Township including the Central Fire Station. Township Fire Brigade Department has 30 extinguishing vehicles, eight water carrying vehicles and six assisting vehicles together with six light machines. The Man Power of Fire Brigade Department is composed of permanent firemen and reserved members of including 24 firemen and 807 reserved firemen.

When the availability of water for fire extinguishing vehicles, these are extinguishing tugs, tanks and canals in the wards. There are 143 extinguishing tugs, 31 tanks, four natural ponds, four canals and two elevated water tanks. Moreover, Thingaza creek, Mandalay moat and

Ayeyarwady River 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 Aungmyethazan Township. The largest number of extinguishing tugs is found in Palengweyaung ward while Amarahtani -West and Mahazayarbon ward are installed with the least numbers of tugs. The installation of the extinguishing tugs and tanks 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 presentation work. It is found that, however, some wards have not only the sufficient numbers 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 Aungmyethazan Township.

A fire station in Aungmyethazan 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, 700, 800, 1200 and 1500 gallons of waters are provided to the fire stations. Among the various types of extinguishing vehicles 450 gallons capacity vehicles can serve only about 2 minutes in case of fire while 1500 gallons capacity vehicles can extinguish fire only 7 minutes. When the water runs out while extinguishing fire, the necessary water is supplied with subordination or shuttle by means of light machines and assistant vehicles from water sources. In Mandalay City, necessary water for extinguishing vehicles is distributed by No (3) pumping station, Malun ward in Chanayethazan Township. Nyaunggwe pumping station No.4 in Aungmyethazan Township and No.2 water pumping station in Chanayethazan Township.

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

No	Ward	Area	Building	Household	Tugs	Tanks	Stations	No of Cars
1.	Pyigyikyetthayay- East	0.08	408	433	12	1	1	-
2.	Pyigyikyetthayay- West	0.10	822	911	12	1	-	-
3.	Thirimarlar- Eest	0.18	1,891	2,054	9	2	1	2
4.	Thirimarlar- West	0.22	822	1,788	9	2	1	2
5.	Minde Ekin	0.99	3,168	3,739	13	2	1	2
6.	Aungmyethazan	0.37	2,310	3,010	17	1	1	3
7.	Palengweyaung	0.14	1,021	1,247	18	2	1	3
8.	Maygagiri	0.27	1,056	1,121	16	1	1	2
9.	Pyilonechantha	0.11	1,500	1,489	5	1	1	2
10.	Pyigyianlon	0.11	2,125	2,207	10	1	1	2
11.	Amarahtani- West	0.05	833	1,009	3	2	1	2
12.	Amarahtani- East	0.35	2,492	3,084	5	1	1	2
13.	Nyaunggwe	0.30	2,100	3,286	-	4	1	2
14.	Obo	0.34	951	1,222	-	2	1	1
15.	Uboketaw	3.91	1,712	2,063	5	1	1	2
16.	Phonedautoe	1.64	611	783	-	2	1	1
17.	Dawnabwar	0.13	2,954	3,403	-	2	1	2
18.	Ahnaketaw	1.53	1,560	1,756	6	2	-	-

19.	Mahazayarbon	0.17	533	946	3	1	-	-
	Total	11.02	29,798	35,551	143	31	16	30

Source: Fire Brigade Department in Aungmyethazan Township

Spatial Analysis of Fire Stations

The main aim of this research is to evaluate the fire safety, prevention, search and rescue of natural disaster of Aungmyethazan Township. This paper is a research work on the danger of fire to analyze the spatial distribution of fire stations and to evaluate their efficacy for the numbers of buildings and residents. Management for the control and prevention of fire is depending on the availability of water, population, buildings, existence of the fire stations and capability of the Fire Brigade Department. Therefore, spatial distribution of fire stations is studied to determine the effectiveness of fire preventive measures. In order to analyze the spatial distribution of fire stations, a Cluster and Outlier Analysis and Multi Ring Buffer Methods are used. Firstly, the mean center for the location of fire station is determined for Aungmyethazan Township. It is found in Pylonchantha ward.

There is a probability of effectiveness of fire preventive measure which varies with the distance from the central area - the highest probability in the nearest areas and the lowest probability in the furthest areas.

Spatial distributions of fire stations are examined with building weigh value. It is found that, the wards of least prevention from danger of fire are Thirimarlar-East, Thirimarlar-West, Palengweyaung, Pyigyikyethayay-East. The danger- zones needed to make fire precaution because the largest number of houses, narrow and congested road networks and inflammable materials are found there. Obo, Uboketaw, and Phonedawtoe wards are the areas with sufficient prevention for the dangers of fire. (Map 3).

When the spatial distribution of fire station is examined by means of Multi Ring Buffer Method, it is found that there are two fire stations in the 500 meter radius from the mean center, three fire stations between 500 and 1,000 meter radius, three fire station between 1,000 and 1,500 meter radius, only one fire station between 1,500 and 2, 000 meter radius, four fire stations between 2,000 and 2,500 meter radius and three fire stations in the remaining radius from the mean center of Aungmyethazan Township. Therefore, the number of the fire stations is the largest within 1000-meter distance from the mean center and the danger of fire can be effectively prevented in this zone. The area lies the time of the land in 500-1,000-meter buffer zone is Pylonchantha, Amarahtani-West, Amarahtani-East, Maygagiri, Pyigyianlon wards. It is found that the areas with the lie of the land in 1,500-2,000-meter buffer zone are Palengweyaung, Aungmyethazan, Nyaunggwe, Pyigyiketthayay-Eest wards. Thirimarlar-West, Thirimarlar-East, Minde Ekin and Uboketaw wards are lies in the 2,500-meter buffer zone from the mean center. Dawnabwar, Ahnaketaw, Obo and Phonedawtoe ward are lies outside the 2,500-meter buffer zone from the mean center. (Map 4)

Therefore, it is found that the most dangerous places for the outbreak of fire are Thirimarlar-East, Thirimarlar-West, Palengweyaung, Pyigyikyethayay-East wards in the township. Therefore, it is an important requirement for the wards to be supplied 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 to the source of water is a critical factor to prevent from the danger of fire. As a result, one can say that the areas close to the mean center with fire station can obtain sufficient protection from the danger of the fire.

Conclusion

The land uses for the structure of road network, the building, and the availability of water, population, economic activities and governmental policies play a critical role in the study of spatial distribution of the fire stations and effectiveness of fire preventive measure. Governmental policy particularly plays an important role in allocation of the fire stations for with prevention and control. There are three wards, with sufficient number of fire stations and nine wards with moderately efficient fire station and four wards with the least prevention by the fire stations. As a result, the areas close to the mean center with fire station can obtain sufficient protection from the danger of the fire. Therefore, it is found that the most dangerous places for the outbreak of fire the township. And then, it is an important requirement for the wards to be supplied and installed with extinguishing tugs and tanks. Besides, it is also equally important to maintain the tugs and tanks from damages. For this reason, an easy access to the source of water is a critical factor in danger of fire. New fire stations are necessary to be opened in the least fire prevented wards; especially in Dawnabwar ward where the largest number of fire break is suffered. It is also necessary to open new fire stations in Obo, Ahnaketaw, Phonedawtoe wards which lies in the furthest from the mean centers of Aungmyethazon Township.

As a mean of fire prevention, the following tasks should be carried out such as the expression of force of fireman and the number of fire engines, the clearing and relocation of the encroached slums and squatter areas, the expansion of roads and streets for the good accessibility for the fire engines and supplying of adequate water. Also the campaign for the construction and reconstruction of the buildings in accordance with the prescribed municipal standards and making efforts to use the fuel stove systematically in various restaurants and cafeteria should be implemented.

For the safety and toward off fire, the concerned administrative department and municipality take the responsibility and discharge their duties daily. In the fire prone district of the encroached squatter areas and building crowded patches in the township, advanced housing estate projects are implemented relocating the victimized families of fire.

If the above problems were solved, cautiously and systematically by the authorities concerned and if the public abides by the rules and laws of the state and authorities of the township, the township would become more developed and would become an up to-date modern urban center of the city. The people of Aungmyethazan Township can live peacefully and securely away from the danger of natural disasters.

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 the research and their encouragement. We are greatly indebted to Dr Khin Win, Professor and Head of Department of Geography and Dr Nay Aung, 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.

References

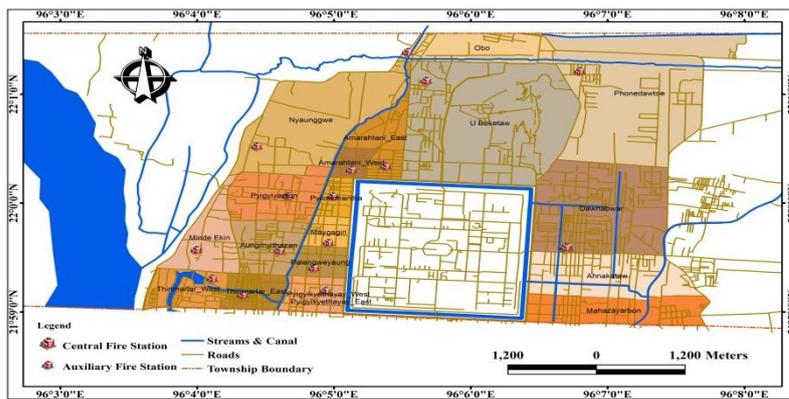
Audrey, N. Clark (1992): Longman Dictionary of Geography

Fellmann, Getis (2007): Human Geography, Landscapes of Human Activities.

Herbert Arkin & Raymonel R. Cotton (1965): Statistical Methods, Barnes & Noble, Inc. Collage outline Series
No.27, pp.74~128

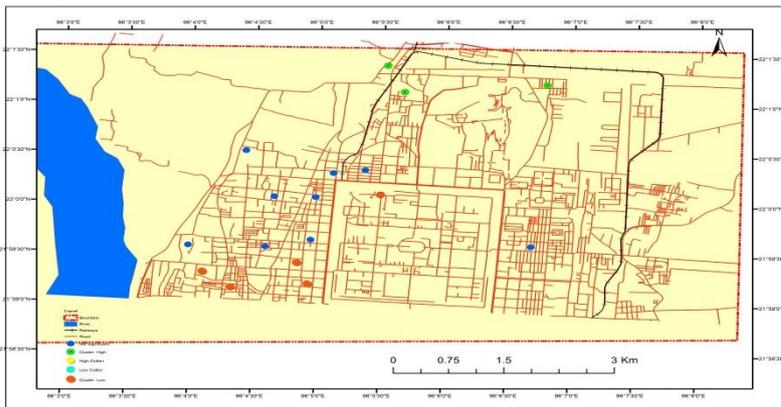
Mandal, R.B. (1982): Land Utilization, Concept, Publishing Company, New Delhi, 87, 117-240.

MAP (2) Spatial Distribution of Fire Stations in Aungmyethazan Township



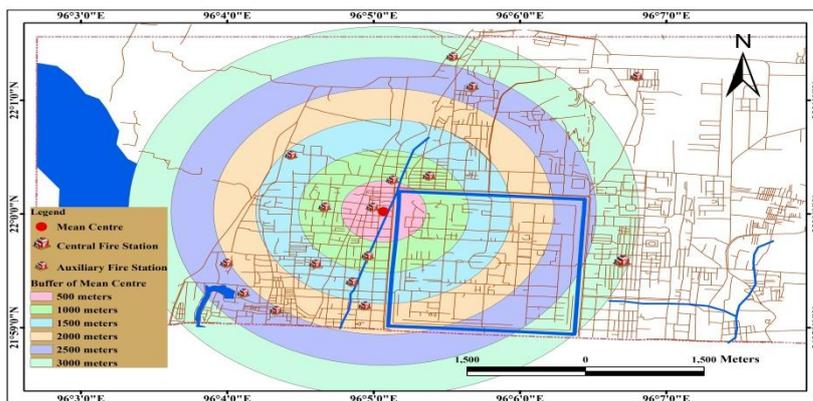
Source: Computed by the Researcher, Field Survey

MAP (3) THE RELATIONSHIP BETWEEN FIRE STATIONS AND BUILDING IN AUNGMYETHAZAN TOWNSHIP



Source: Computed by the Researcher, Field Survey

MAP (4) Spatial Distribution of Fire Stations in Aungmyethazan Township by Using Multi Ring Buffer



Source: Computed by the Researcher, Field Survey

