DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

EXAMINING THE LOGISTIC POINTS IN THE INDEPENDENCE WAR OF TURKEY USING SPATIAL STATISTICS AND GIS

by
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May, 2014
İZMİR

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A Thesis Submitted to the
Graduate School of Natural and Applied Sciences of Dokuz Eylül University
In Partial Fulfillment of the Requirements for the Master of Science in
Geographical Information System

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May, 2014
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M.Sc THESIS EXAMINATION RESULT FORM

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ACKNOWLEDGMENTS

I would like to gratefully and sincerely thank Assoc. Prof. Dr. K. Mert ÇUBUKÇU for his guidance, understanding, patience, and most importantly, his friendship during my Thesis study. He encouraged me to not only finish my study and do my best, but also to think and imagine in all aspects of the topics in detail.

Also I would like to express my very sincere gratitude to Assistant Assoc. Prof. Muhammed AYDOĞAN for efficient lessons together.

Finally, and most importantly, I would like to thank my beloved wife Gözde BOZOĞLU. Her support and encouragement made everything easier for me. Her tolerance and patience was always with me. My sincere thanks also goes to my parents Ayfer and Özer BOZOĞLU because of their encouragement me to start studying master degree and for their faith in me.

Mustafa BOZOĞLU

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ABSTRACT

After the defeat in World War I, the Turkish Nation was struggling with poverty, starvation, diseases and battle fatigues, while the Allies were occupying Turkish country. Despite all the negativities, the Turkish Grand National Assembly and the Turkish Army had overcome all the challenges of the war with a remarkable effort. As well as eligible strategies and tactics of Turkish Army, it is clear that for a decisive victory there needs to have an operative and a wise logistics support system. This successful logistics support system is examined by the help of spatial statistics and GIS in this study.

Generally the most essential logistic points for an army in the field were chosen to study. With the help of the GIS technology, as an extensive database was developed and statistical analyses were combined with visual representations and geographic analyses. Spatial analysis properties can be categorized under three headings in our work: Measuring central tendency, measuring statistical dispersion and measuring of geographic distribution.

As a result locational choices regarding the logistic points are far from being random in The Independence War of Turkey. Only the distribution of supply warehouses is random. The rest of logistic points have dispersed pattern. Closeness to transportation networks and resources were considered. Locational choices were made to obtain a dispersed distribution of logistic points to operational area.

Keywords: Geographical information system, spatial statistics, The Independence War of Turkey, logistic points.

TÜRK KURTULUŞ SAVAŞINDAKİ LOJİSTİK NOKTALARININ MEKANSAL İSTATİSTİK VE CBS İLE İNCELENMESİ

ÖZ

Birinci Dünya Savaşı sonrası, Türk ulusu yoksulluk, açlık, hastalıklar ve savaş yorgunluğu ile meşgul iken İtilaf devletleri Türk yurdunu işgal ediyorlardı. Bütün olumsuzluklara rağmen Türkiye Büyük Millet Meclisi ve Türk ulusu, büyük bir azim ile savaşın tüm zorluklarının üstesinden geldi. Türk ordusunun nitelikli stratejileri ve taktiklerinin yanı sıra, kesin zafer için operatif ve akıllı lojistik destek sistemine ihtiyaç vardı. Bu çalışmada, bu başarılı lojistik destek sistemi mekansal istatistik ve CBS'nin yardımıyla incelendi.

İnceleme için, bir ordu için harekattaki en önemli lojistik noktaları seçildi. CBS teknolojisinin yardımıyla, geniş bir veritabanı oluşturularak, istatistik analizler, görsel sunumlar ve coğrafi analizlerle birleştirildi. Çalışmamızda mekansal analiz üç başlık altında kategorize edilebilir: Merkezi eğilimin ölçülmesi, istatistiksel yayılımın ölçülmesi ve coğrafi dağılımın ölçülmesi.

Sonuç olarak Türk Kurtuluş Savaşındaki lojistik noktaların yerlerinin seçimi rastlantısal olmaktan çok uzaktır. Sadece erzak ambarlarının dağılımı rastlantısaldır. Diğer lojistik noktalar dağınık yerleşim modelidir. Yol ulaşım ağlarına ve kaynaklara yakınlık dikkate alınmıştır. Lojistik noktaların mekansal seçimleri harekat bölgesinde yaygın dağılmıştır.

Anahtar kelimeler: Coğrafi bilgi sistemleri, mekansal istatistik, Türk Kurtuluş Savaşı, lojistik noktalar.

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CHAPTER ONE
INTRODUCTION

After the defeat in World War I, the Turkish Nation was struggling with poverty, starvation, diseases and battle fatigues, while the Allies were occupying the country. The Independence War of Turkey began under these difficult conditions, when Mustafa Kemal landed in Samsun on the May 19, 1919. The purpose was to maintain unconditional sovereignty and complete independence, which means not to defend a specific part of the country, but the whole.

When the Grand National Assembly was founded on April 23, 1920, in Ankara, approximately 38,000 English, 59,000 French, 18,000 Italian soldiers and a 90,000 soldier Greek Army were deployed within Turkey. Apart from that, it was a necessity to take measures against nearly 10,000 armed Armenian militias supporting French occupy in the South Anatolia and about 20,000 armed Portic Greeks in the Black Sea Region (Timur, Atakan, Berktay & Ertekin, 1975).

Despite all the negativities, the Turkish Grand National Assembly and the Turkish Army had overcome all the challenges of the war with a remarkable effort. On the whole, these achievements against the difficulties make the war very heroic and a success story in the Turkish Nation's recent history. As well as eligible strategies and tactics of the army, it is clear that for a decisive victory there needs to have an operative and a wise logistics support system. This successful logistics support system is examined by the help of spatial statistics and GIS in this study.

Establishing and maintaining a logistic support system and units was one of the hardest parts of the war considering 227,807 Turkish soldiers and 79,894 animals on the Western Front, just before the Great Assault on August 01, 1922 (Timur et al. 1975).

Mustafa Kemal Pasha, as the Supreme Commander of the Turkish Army, had all the authorizations of the Turkish Grand National Assembly on August 05, 1921. To

start with, he issued the ordinance known as the National Obligations (Tekalifi Milliye). With the help of this ordinance, the deficiency of the army had been overcome logistically, and the Turkish Army defeated the Greece Army in Anatolia with a precise triumph. Turkish Army defeated all the enemies owing to the great help and exertions of the Turkish Nation adding to a well-organized logistic support system.

It will be useful to share the fronts during The Independence War of Turkey in Figure 1.1. The locations of the fronts are determinative for the locations of logistic points.

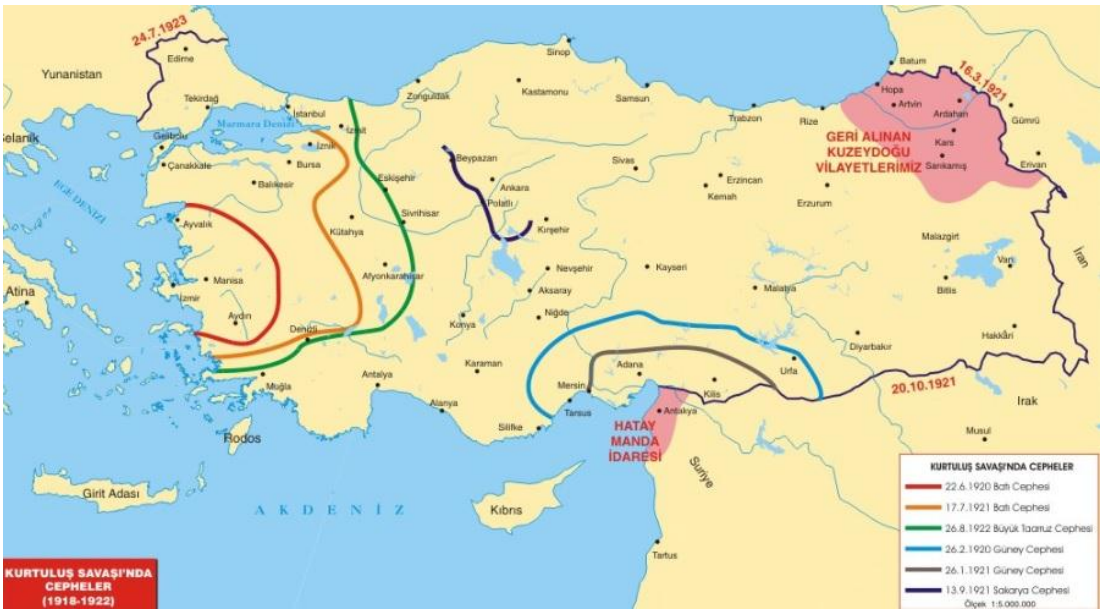


Figure 1.1 The fronts in The Independence War of Turkey by dates where ("Batı Cephesi" means Western Front, "Büyük Taaruz Cephesi" means Great Assault Front, "Güney Cephesi" means South Front, and "Sakarya Cephesi" means Sakarya Front) (Ekvator Harita, nd.).

As a military term logistics means planning and executing the movement and supporting of forces. It includes those aspects of military operations that deal with:

a. Design and development, acquisition, storage, movement, distribution, maintenance, evacuation and disposition of materiel;
b. Movement, evacuation and hospitalization of personnel;

c. Acquisition or construction, maintenance, operation and disposition of facilities;
d. Acquisition or furnishing of services (US Department Defense Dictionary of Military and Associated Terms, 2013, p.178).

At the beginning of The Independence War of Turkey, armaments and the sustainability of replenish resources had to be provided, in order to establish an army supply. For these requirements main resources were:

- weapons, ammunition and military equipments that remained in warehouses within the inner parts of Anatolia,
- weapons, ammunition and military equipments from occupied city Istanbul and its surroundings,
- surplus weapons, ammunition and military equipments from Elcezire (Diyarbakır) Front,
- surplus weapons, ammunition and military equipments from Eastern Front,
- weapons, ammunition, military equipments and also subsidy from Soviet Russia (Timur et al. 1975).

This diversity of resources shows the complexity of logistic support with varied routes and necessity of systematically scattered warehouses within the country.

Throughout the history, almost all the armies have been trying to organize their logistic support to have success in war. Besides food supply, military equipments and armaments, transportation, medical treatment, evacuation, maintenance and repair are the most significant logistic factors, which have great impacts on winning a war. These logistic factors for the Turkish Army during The Independence War of Turkey are shown on the map in Figure 1.2.

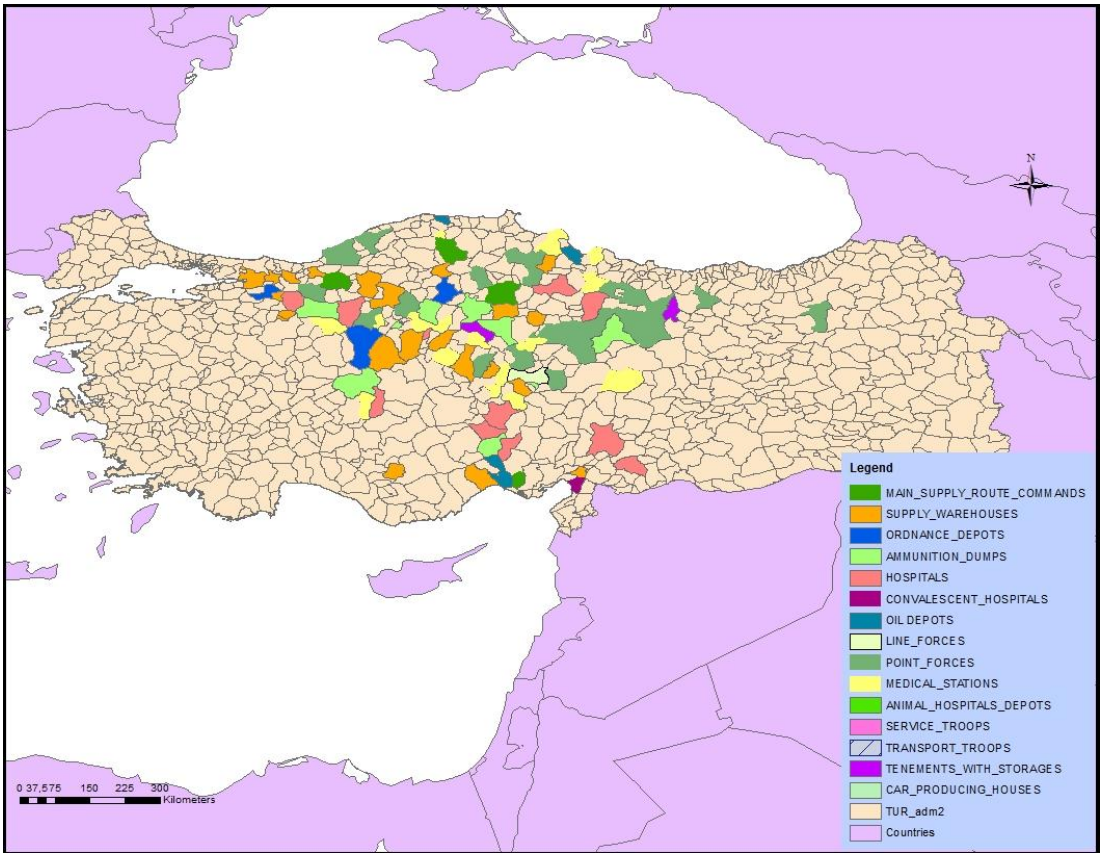


Figure 1.2 Logistic factors as logistic points in The Independence War of Turkey

As the famous military strategist Sun Tzu said, there are five kinds of incendiary attack: The first is called setting fire to personnel; the second, to store; the third, to transport vehicles and equipment; the fourth, to munitions; the fifth, to supply installation. In all cases an army must understand the changes induced by the five kinds of incendiary attack, and make use of logistical calculations to address them (Ames, 1993, p.165).

In recent digital era, for military commanders Geographical Information System (GIS) is a privilege and an excellent tool. Military forces have revolutionized methods for operations and functions with the use of GIS applications. For today, military forces use variety of GIS applications including monitoring of possible terrorist activities, battle field management, terrain analysis, intelligence, military installation management, remote sensing and cartography. In military logistics, using GIS gives the capability of moving supplies, troops, and equipments where they are needed at the right place and at the right time. In case of a traffic jam or a mishap,

establishing alternative routes for convoys with using GIS will be helpful for saving damage, time and cost (Satyanarayana & Yogendran, 2002).

For today's military commanders to give the most correct decision it is of crucial importance to be able to present information on a map, filtering and analyzing data. This makes GIS and digital mapping very important for decision makers. And one of the most important requirements for Military Commanders is to plan logistic support in detail. Field Marshall Montgomery said ''During the last war, eighty percent of our problems were of a logistical nature". To be able to combine GIS technology and logistic support plan will help to solve the problems more accurate with saving time, effort and money. It's not enough to have a brilliant strategy; a well organized logistic system is necessity for a victorious army (Satyanarayana & Yogendran, 2002).

At first glance the title of the study gives the impression as it is a kind of historical research but it is more than that. It is very actual and contemporary for ascertaining. Although it seems The Independence War of Turkey is one of the most well-known touchstones in Turkish recent history, there are still lots of parts missing and unexplored. Previous studies were generally based on logistics activities during The Independence War of Turkey. To date no research has been done using spatial statistics.

In this study, the spatial distribution of logistic points, as the components of logistic support system, is studied using GIS and spatial statistics. It was intended to reveal the relation between location of logistic points and the possible reasons of their dispersions in the operational area.

The remaining parts of the study are organized as follows. Chapter 2 presents the method used in the analyses in detail with the definitions and the formulations. Chapter 3 includes the data with the selected logistic points with their explanations. Chapter 4 presents the findings of analyses. Chapter 5 concludes the study with remarks and evaluation of the result.

CHAPTER TWO
METHOD

A Geographic Information System (GIS) has various useful tools in order to have an interactive visualization of qualified data for a better understanding. With the help of GIS computer programs (Esri Arcgis, Mapinfo Professional, Intergraph Geomedia and so on) the user have the capability of operating statistical methods and analyzing spatial patterns using spatial data. The facility of integration GIS functionality with spatial analysis quantifies the features as measuring geographic distributions, analyzing patterns and mapping clusters concerning primarily points, lines and polygons.

Spatial statistics has been developed in particular for assessing spatial data with geographic information. Spatial statistics is useful for describing the characteristics of a spatial distribution and identifying the spatial pattern. It can be used for a better understanding of complicated spatial datasets, to help describing the patterns and relationships.

In an interview to a question of why people should consider using spatial statistics, Dr. Lauren Scott, product engineer on ESRI's geoprocessing team and an expert in the use of statistics in a geospatial context, answers as below:

> We analyze our data outside of their spatial context-when we remove space and time from our data-it's like we're only getting half the story. Things happen in space and time, and if we ignore that, our analysis is going to be incomplete. This is an important difference between traditional statistics and spatial statistics: traditional statistics often make the assumption that data are free of something called spatial autocorrelation (Scott, 2010, p. 01).

In a vector GIS, geographic features are defined by points, lines, or polygons in a two-dimensional or three-dimensional space. A point, as a geographic feature, represent no space extent or very little of it, but represents a location. Linear features

are represented mostly by lines, and areal units or regions are usually represented by polygons in a vector GIS database. Even the geographic features can be represented mostly by points, lines, and polygons; this is not a constant representation. The important determinant is the scale. A geographic feature can be represented by a point in a small scale map, but by a polygon or a line in a large scale map (Lee & Wong, 2001).

In this study, compatible with the map scale, the locations of logistic points are represented by points. They are the centroid of the county polygons, where each logistic point is located. With the help of the GIS technology, as an extensive database was developed and statistical analyses were combined with visual representations and geographic analyses.

Spatial analysis properties can be categorized under three headings in our work:

(1) Measuring central tendency,

(2) Measuring statistical dispersion,

(3) Measuring of geographic distribution.

It will be useful to explain briefly the tools used for spatial analysis in this study. Mean Centre is used for measuring central tendency; Standard Distance and Standard Deviational Ellipse for measuring the statistical dispersion, and lastly Nearest Neighbor Analysis for measuring point distribution. Their definitions and formulations are expressed below.

2.1 Mean Centre

Central tendency usually is the first step of analyzing attribute data. Mean is the average value and the most common tool in order to measure central tendency. In spatial analysis, the mean centre represents the average location with a locational data in two dimensions (x, y coordinates). It is helpful for following up the variations in the distribution.

When the coordinates of each point is decided and the coordinate system has been set, by separately averaging coordinates Y (northings) and X (eastings), mean centre can be calculated as the formula below (Sahoo, 2002):

$$(\bar{x}_{mc}, \bar{y}_{mc}) = \left(\frac{\sum_{i=1}^{n} x_i}{n}, \frac{\sum_{i=1}^{n} y_i}{n} \right) \quad (2.1)$$

where

$\bar{x}_{mc}, \bar{y}_{mc}$ are coordinates of the mean centre,

x_i, y_i are coordinates of point i,

n is the total number of points.

2.2 Standard Distance

As the mean centre is like a locational analogue to the mean, spatial equivalent of standard deviation is the standard distance. In a point pattern, the standard distance measures the amount of spatial dispersion. First, the locational coordinates of the mean centre are derived. The standard distance statistic unites the Euclidean distance or straight-line of each point from the mean centre (Sahoo, 2002).

For the standard distance (S_D), the formula of point distribution is given as follows (Sahoo, 2002):

$$S_D = \sqrt{\frac{\sum_{i=1}^{n} (x_i - x_{mc})^2 + \sum_{i=1}^{n} (y_i - y_{mc})^2}{n}} \quad (2.2)$$

where

$(\bar{x}_{mc}, \bar{y}_{mc})$ is the mean centre of the point distribution,

x_i, y_i are coordinates of point i,

n is the number of points.

2.3 Standard Deviational Ellipse

Directional distribution also known as the standard distance circle is a very powerful tool to indicate the spatial spread of the point locations. Standard deviational ellipse is a reasonable extension of the standard distance circle. Standard distance has the directional prejudgment in a point distribution, as it always defines a circle. However, standard deviational ellipse has no such assumption.

There are three parts in defining a standard deviational ellipse: (1) the deviation along the minor axis as the shorter one, (2) the deviation along the major axis as the longer one, and (3) the angle of rotation. If the points display specific directional distribution, at that time there will be a trend in the direction of the ellipse to cover most of the points in the dataset (Lee & Wong, 2001).

In the Cartesian coordinate system, the two axes can be considered as the y and x axes, but rotated to a specific angle seems like geographic orientation of the point distribution. The angle between the y axis and the north rotated clockwise is this angle of rotation. Paying attention to the rotated y axis can be either the minor or major the axis. Demonstrations defined a standard deviational ellipse in Figure 2.1 (Lee & Wong, 2001).

To derive the standard deviational ellipse, the followings are to be calculated:

- the coordinates of the mean center (x_{mc} , y_{mx}),

- the deviations of the xy coordinates from the mean centre, x_i^u and y_i^u (Lee & Wong, 2001), where:

$$x_i^u = x_i - x_{mc} \qquad y_i^u = y_i - y_{mc}$$

- angle of rotation is the subsequent step. Remark that, tan θ can be negative or positive:

$$\tan\theta = \frac{\left(\sum_{i=1}^{n} x_i^{u^2} - \sum_{i=1}^{n} y_i^{u^2}\right) + \sqrt{\left(\sum_{i=1}^{n} x_i^{u^2} - \sum_{i=1}^{n} y_i^{u^2}\right)^2 + 4\left(\sum_{i=1}^{n} x^u \sum_{i=1}^{n} y^u\right)^2}}{2\sum_{i=1}^{n} x_i^u \sum_{i=1}^{n} y_i^u} \quad (2.3)$$

In order to calculate deviation from the *x* axis and from the *y* axis:

$$\sigma_x = \sqrt{\frac{\sum_{i=1}^{n}\left(x_i^u \cos\theta - y_i^u \sin\theta\right)^2}{n}} \qquad \sigma_y = \sqrt{\frac{\sum_{i=1}^{n}\left(x_i^u \sin\theta - y_i^u \cos\theta\right)^2}{n}} \quad (2.4)$$

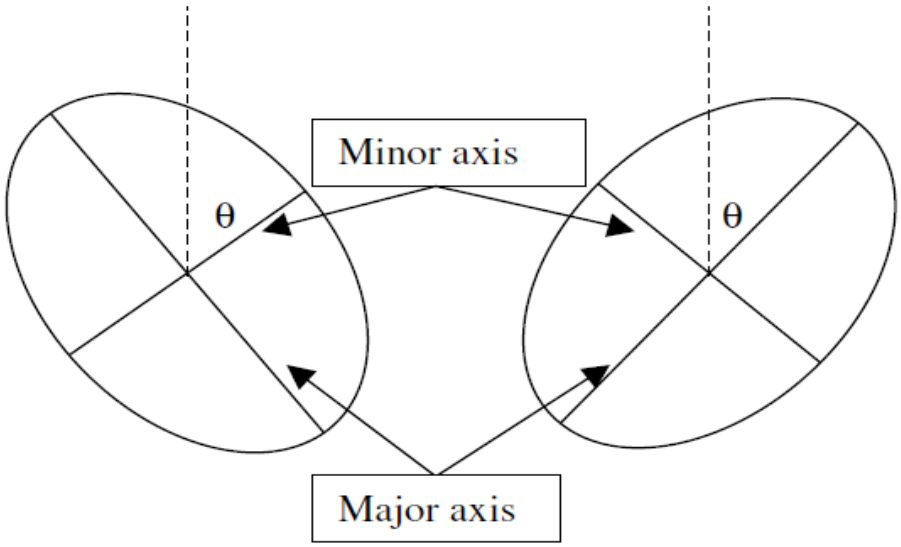


Figure 2.1 Defining a standard deviational ellipse (Lee & Wong, 2001).

2.4 Nearest Neighbor Analysis

Nearest Neighbor Analysis is an analysis to examine the spatial pattern of a point dataset. First, the nearest points in the dataset to each point are found and the nearest distances are measured. Then the average of these nearest distances is found as the observed nearest distance. The expected nearest distance is then calculated. To the expected average distance between nearest neighbors ($r_{\exp}$) is found by:

$$r_{\exp} = \frac{1}{2\sqrt{n/A}} \quad (2.5)$$

in the distribution the *n* is the number of points and the *A* is the space of the distance of concern (Lee & Wong, 2001).

If the average space is less than the average distance for a theoretical random dispersion, the distribution of the features being analyzed are considered to be clustered. When the average observed distance is greater than the one for the theoretical random dispersion, the features are considered dispersed. Nearest Neighbor Ratio is explained as the ratio of the observed distance divided by the expected distance. This expected distance is based on a theoretical random dispersion with the same number of features containing the same total area. When the Nearest Neighbor Ratio is less than one, the pattern is to be clustered. If Nearest Neighbor Ratio is greater than one, the inclination is to dispersion. Data distribution example for point data is shown in Figure 2.2 (Esri, 2009).

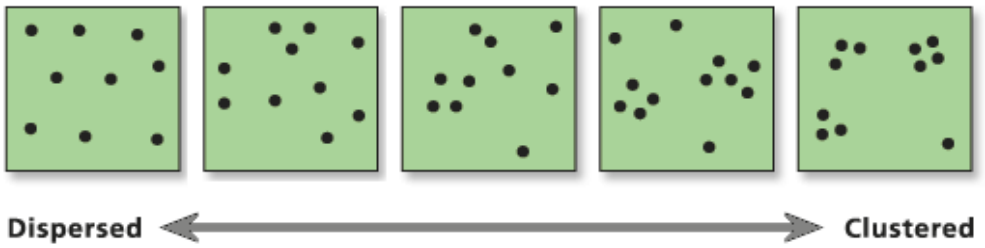


Figure 2.2 Point data distribution example (Esri, 2009).

Types of Distributions:

- When the points are quite enough away from its neighbors, it is called ‘dispersed’ in other words ‘uniform’ type distribution.
- When the points are equally likely to be at any place, and the location of any point is not affected by the location of any other point, it is called ‘random’ type distribution.
- When many points are coming together and if the points are most probably close to each other, it is called ‘clustered’ type distribution (Briggs, 2007).

To calculate the observed average distance between nearest neighbors (r_{obs}), it is a need to measure the distance between points and all of its neighbor points. And the shortest distance in these neighbors will be united with the nearest point.

It is obvious that geographic object distributions are usually not in standard types. To determine the style of distribution in a space it is a requirement to have the Nearest Neighbor Ratio (*R* scale). And the formula for *R* scale is:

$$R = \frac{r_{obs}}{r_{\exp}} \tag{2.6}$$

where r_{obs} is the average distance between nearest neighbors and $r_{\exp}$ is the expected average distance between nearest neighbors.

With the help of *R* scale calculation, it is easy to decide distribution type is whether more clustered or more dispersed. For a detailed analysis, it will be useful to determine the degree of being more clustered or being more dispersed than a random type.

Being dispersed, random or clustered is directly connected with the *R* values. When *R* value is relatively smaller, this indicates a more clustered pattern ($r_{obs} < r_{\exp}$). When *R* value is larger it is a more dispersed pattern ($r_{obs} > r_{\exp}$). In Figure 2.3, it is clearly shown that how *R* values relate to varied patterns. Actually it is not enough to measure the difference between a completely clustered pattern when the *R* value is zero. When *R* value is equal to one, this means it is a random distribution. To be a complete dispersed distribution *R* value must be 2.149. For a complete clustered distribution (*R* = 0), all spaces between points are zero, showing that all points are found at the same place. When the *R* value is 1, also means $r_{obs} = r_{\exp}$, this is a random pattern. If the *R* value is about 2 or more, the pattern indicates various degrees of dispersion (Lee & Wong, 2001).

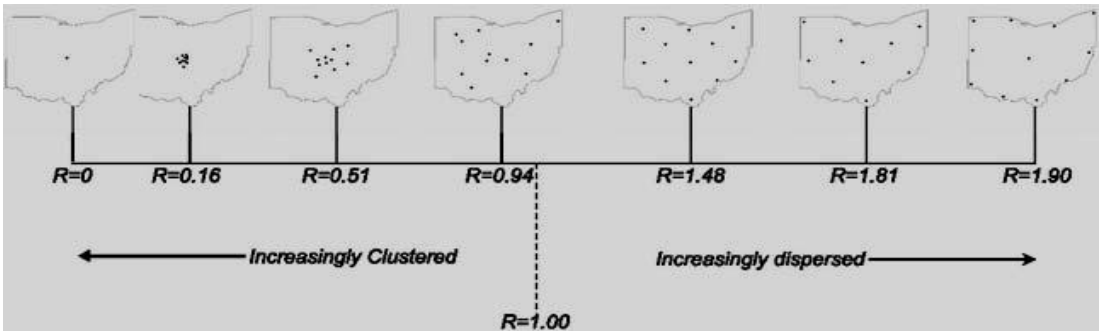


Figure 2.3 The scale of *R* statistics (Lee & Wong, 2001)

However, the ratio *R* does not provide information on the statistical significancy of the result. p-values, z-scores and confidence levels is explained and fortified with the Table 2.1 below. The p-value is the probability. It is the probability that the observed spatial pattern was formed by a non-random process. When the p-value is very small, this indicates that the observed spatial pattern most probably is not a random distribution, this makes null hypothesis to be rejected. The null hypothesis is that the observed point distribution has a random distribution (Esri, 2009).

Table 2.1 Standard deviations, probability and confidence level (Esri, 2009).

z-score (Standard Deviations)	**p-value (Probability)**	**Confidence level**
< -1.65 or > +1.65	< 0.10	90%
< -1.96 or > +1.96	< 0.05	95%
< -2.58 or > +2.58	< 0.01	99%

CHAPTER THREE
DATA

A war is a multifactorial decision process. In a war, the judgment choosing correct locations for the logistic points are directly proportional with the success of the army. In The Independence War of Turkey, to be able to defeat the enemy and make them leave the Turkish homeland, there needs to be a decisive victory. Supreme Commander Mustafa Kemal was aware of the fact that the Great Assault was the last chance for a decisive victory. The army must be ready in all respects. And logistics is an important part of the war to have the victory.

Logistics is a wide ranging term. Logistic support in The Independence War of Turkey was concentrated into three main issues. These issues were supply, ordnance and personnel supply. Apart from these, there were also medicals, veterinary medicines and transportation works. So, the excessive workload was on supply, ordnance and recruitment agencies (Timur et al. 1975).

In this study

- Main supply route commands,
- Supply warehouses,
- Ordnance depots,
- Ammunition dumps,
- Hospitals,
- Convalescent hospitals,
- Oil depots

were chosen to study as logistic points. These facilities are generally the most essentials for an army in the field. Locations of studied logistic points are illustrated in Figure 3.1 below.

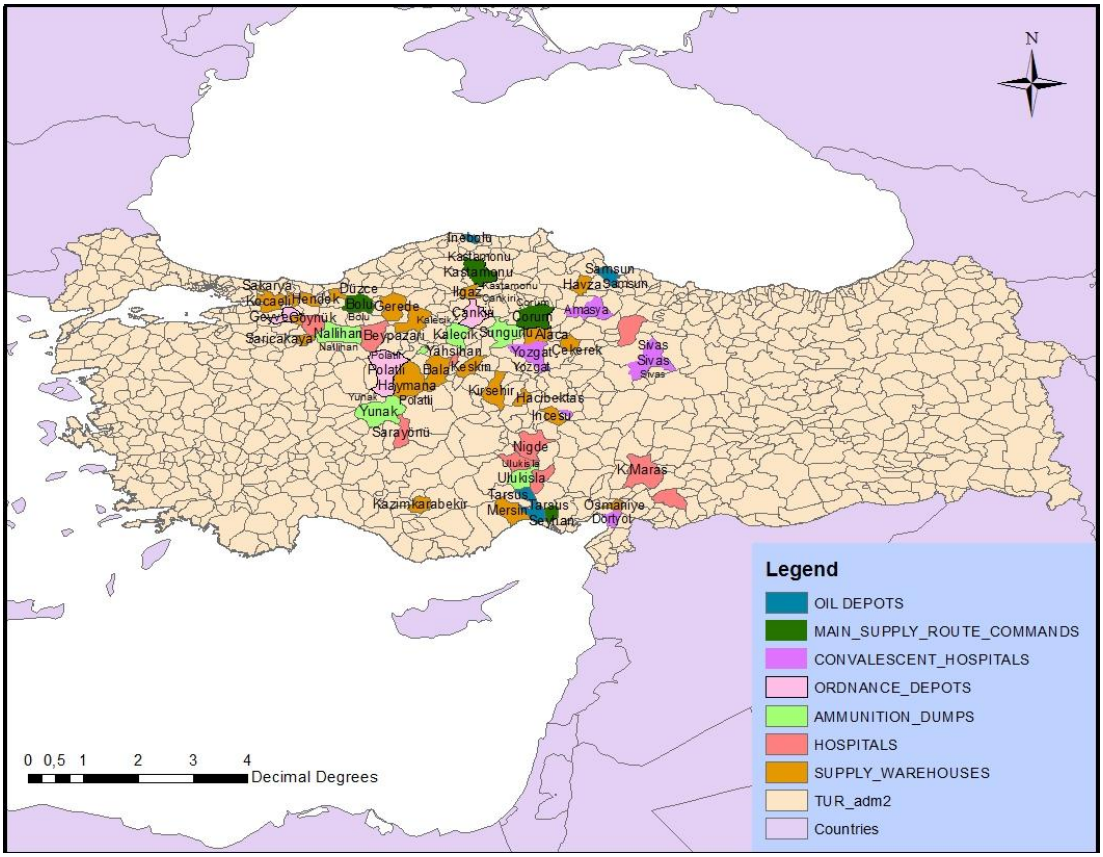


Figure 3.1 Locations of studied logistic points

To assist comprehending the characteristic elements of logistic support and for a better understanding of logistic points task-sharing, classes of supply are given below. In this study, classification of supply is taken account as released by NATO (North Atlantic Treaty Organization). Classes of supply are represented in the five-class system of characterization for NATO as follows:

Class I

It is an item of substance which is food for personnel and forage for the animals. Class I supply is mostly on a uniform rate not connected of local changes in battle or terrain conditions.

Class II

Supply for individual needing of personnel that are like weapons, tools, clothing, vehicles, administrative equipments and housekeeping supplies.

Class III

For all purposes petroleum, oil and lubricants with an exception for operating aircrafts or using petroleum as ammo like flamethrowers, and also including coal, coke, fuel oil, gasoline, and greases.

Class IV

Supplies as construction and fortification materials which initial issue permissions are not defined by confirmed issue tables. Also includes supplementary quantities of items for initial issue identical to the authorized (Class II) like additional vehicles.

Class V

Ammunition of all types, bombs, explosives, mines, rockets and all associated items (North Atlantic Treaty Organization [NATO] Logistics Handbook, 1997).

To be able to understand the size of logistic support, the numbers of soldiers in the Turkish Army just before the Great Assault are given as follows (Timur et al. 1975):

Table 3.1 Number of fronts

Troops	Officers	Privates
Western Front	8,658	199,282
Eastern Front	1,477	25,398
Elcezire Front	580	9,230
Adana and surroundings	147	2,667
The tenth division	333	7,687
Ankara command	89	1,754
Depot troops	350	22,549
Artillery inspector	155	2,325
Flight school	53	219
Military line commissioner	58	1,151
Coast guard troops	7	293
General directorate of shipping and transp.	935	12,854
Institutes in Ankara	471	6,494
Recruitment agencies	1,032	6,292
Total:	14,345	297,794

Total number of 120,433 personnel were newly joined the Turkish Army in 1922. This improvement in the numbers made logistics harder. Nearly all the army was in the field which means they need daily foodstuff, ordnances, ammunition and medical treatments. By 1922, it was quite difficult to supply an army with this size.

In this study, deployment of logistic points by 01 July 1922 just before the Great Assault, is selected as the sample case, because the Turkish Nation and the Turkish Army made a well organized preparation for the outright victorious assault. This successful logistic organization is analyzed by using spatial statistics and GIS.

Administrative districts map of Turkey is used as the vector base map. The locations of logistic points are set to districts. Central districts of provinces, towns, villages and fields are represented as districts. Some of the names of districts have changed by the mean time; every district is used with their recent names in this study.

The coordinate system of data source is GCS: WGS 1984 and the units and the mean centers are Degree, Minutes, Seconds (DDD MM' SS .sss" [W-E]).

Between the years 1919-1922, Turkish Army had to manage logistic support on a large scale in long war period. Logistics support was divided into parts and each part had tasks. Before the analyses and the results, the tasks and the explanations of logistic points are described below.

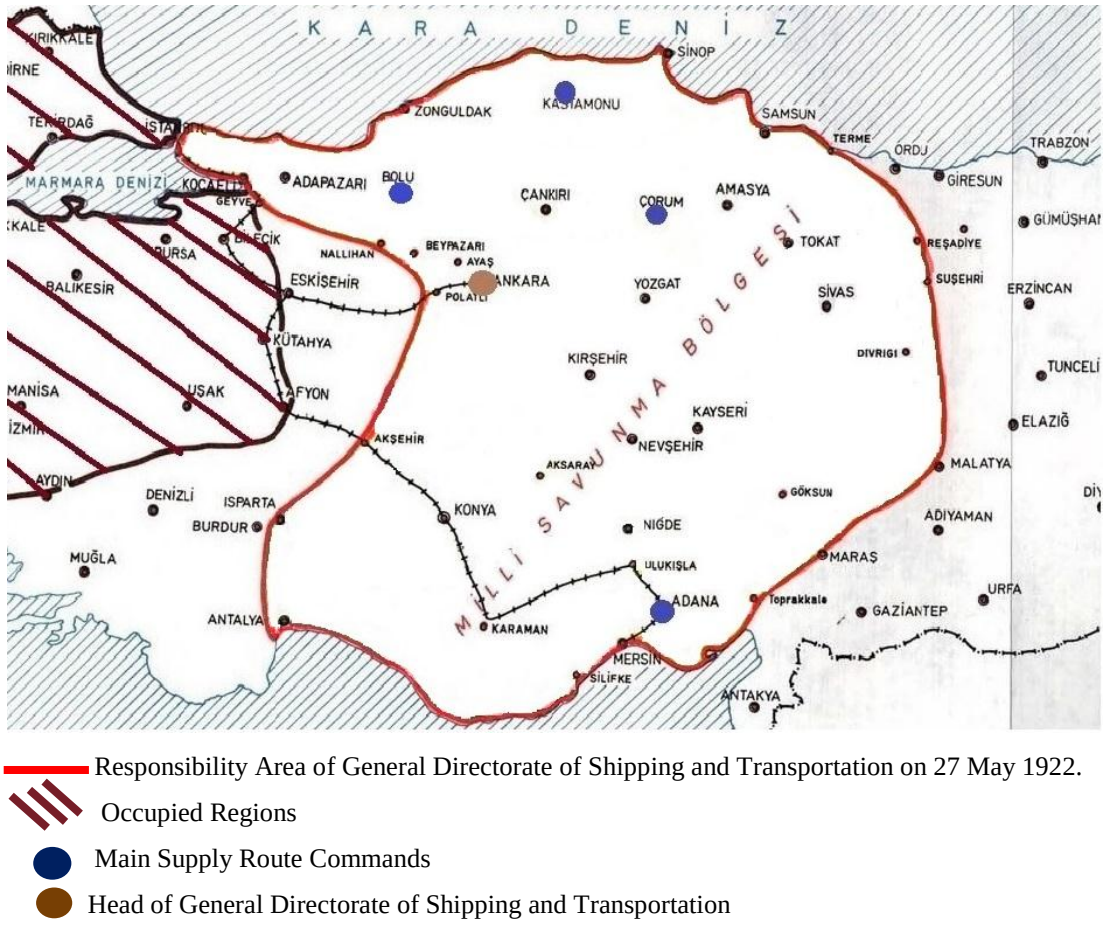
3.1 Main Supply Route Commands

Main Supply Route Commands manage logistic support in their own responsible area. There were totally four Main Supply Route Commands. Their locations were Çorum, Bolu, Kastamonu and Adana provinces. They were directly connected to the General Directorate of Shipping and Transportation in Ankara.

In their responsibility area, the main tasks of Main Supply Route Commands are:

- to provide shipping and transportation in quickest way,
- to accommodate passing troops and individual privates,
- to repair the roads,
- to take security measures and to organize transportation services (Timur et al. 1975).

Responsibility area of General Directorate of Shipping and Transportation map just before the Great Assault is shown in Figure 3.2.



Responsibility Area of General Directorate of Shipping and Transportation on 27 May 1922.

Occupied Regions

Main Supply Route Commands

Head of General Directorate of Shipping and Transportation

Figure 3.2 Responsibility area of general directorate of shipping and transportation (adopted from Timur et al. 1975).

Main Supply Route Commands have the necessary subunits for logistic support. As easily imagined, in war time conditions there needs to be a lot of effort to do the logistic support on time and properly. All logistic points workings in the area were

under main supply route commands responsibility. Logistic points were supply warehouses, ordnance and ammunition dumps, line and point commands, hospitals and hospital subunits, animal hospitals, service troops, oil depots, transport troops, tenements with storages, car producing houses.

Each main supply route command has subunit logistic points. As an example Çorum mean supply route command has one line command, eleven point commands, ten supply warehouses, one ordnance depots, four ammunition dumps, three hospitals, two convalescent hospitals, ten medical stations, two animal hospitals and depots, one service troops, one oil depots, three transport troops. Other mean supply route commands like Bolu, Kastamonu and Adana have nearly the same forms in regard to subunits. But also certainly there were some changes considering the numbers and sorts.

Figure 3.3 The lined carts for transportation of ammunition to the front (Haber3, 2010)

There were five line commands in Sarayönü, Sivas, Kayseri, Yozgat, Kırşehir. They were directly connected to the General Directorate of Shipping and Transportation. Dispersion of all the chosen logistic points such as supply

warehouses, ordnance depots, ammunition dumps, main supply route commands, hospitals, convalescent hospitals, oil depots, are included in our study no matter it is a subunit of a main supply route command or a line command.

3.2 Supply Warehouses

Supply warehouses are the commands storing Class I supply. Before the Great Assault on 19 April 1922, Supreme Commander Mustafa Kemal gave a speech at Council of War meeting to pay attention the importance of food supply:

> Most hazardous issue is the food supply. It is hard to make daily supply. The army has never left to hunger up to now but couldn't perform any supply reserves, either. Owing to lack of foodstuff reserve, even a small maneuver can fail. Money to be obtained will be spent first to daily foodstuff supply and the remaining funds will be spent for performing reserves. Delaying weapon and ammunition replenishment would be appropriate. Funds allocated to weapons and ammos can be withdrawn (Timur et al. 1975, p. 452).

From the beginning of July 1922, Ministry of Defense could perform enough foodstuff reserves for a certain period of time to fronts and especially to the Western Front.

Since the date of very old times, logistics for an army is one of the most important factors that must be taken into account of. A famous saying of Alexander the Great is, my logisticians are a humorless lot… they know if my campaign fails, they are the first ones I will slay (Logistics World, n.d.)

Also to impress the importance of logistics for an army in field, Napoleon Bonaparte, Emperor of France between 1804-1814, said that an army marches on its stomach. He meant even very dedicated soldiers need food and it is a reality they can't fight without eating (Brainy Quote, n.d.).

Also during The Independence War of Turkey, food supply has a vital role as well. Spring 1922 was the decided date for Great Assault but postponed to summer time. Need to have the harvest of the year and waiting the weather conditions getting well enough were the reasons. (Müderrisoğlu, 1990).

It is shown in Figure 3.4, supply warehouses of Western Front and the amounts of foodstuff on September 28, 1920 (Timur et al. 1975). To be able to understand properly, some words in the map are translated to English:

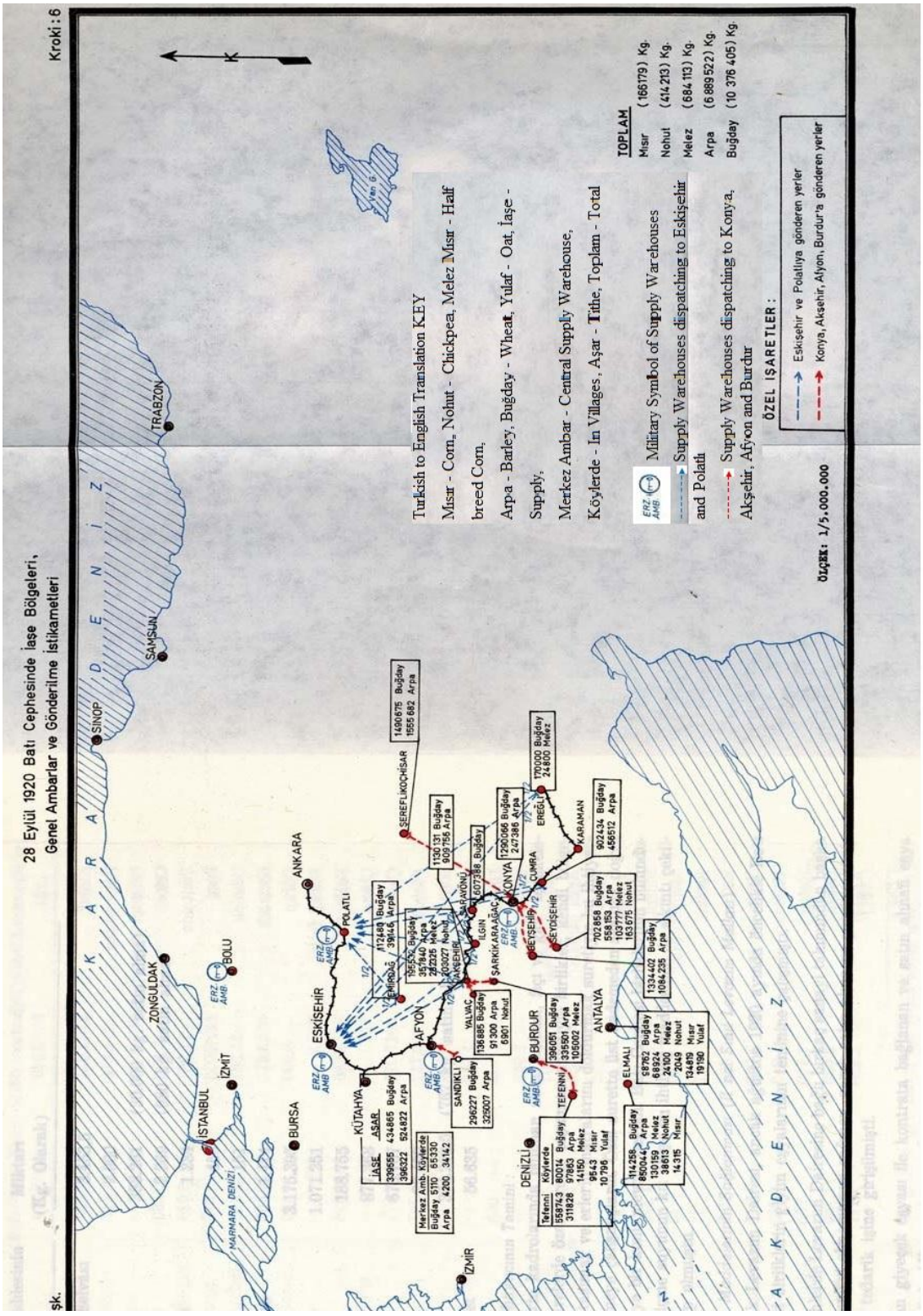


Figure 3.4 Supply warehouses of western front on 28 September 1920 (Timur et al. 1975).

3.3 Ordnance Depots

Ordnance depots are the commands storing Class II supply particularly clothing, weapons, tools and spare parts. The purpose of the depots was to meet the needs of the army. By 1922, the centre of gravity for Class II supply was Western Front because the enemy was deployed in the west. Ministry of Defense made a lot of effort to fulfill the Class II needs of army before the Great Assault.

By May 1922, Western Front mostly needed clothes, portable tents and foot wears. For the lack of portable tents, troops stayed in villages not in field so mobility was not possible for the army. Despite all the efforts, especially clothing needs of army couldn't be provided before Great Assault. The missing was fulfilled during the Great Assault with the help of booty from defeated Greek Army. Between May and July 1922, number of distributed clothes and the remaining need were given below (Timur et al. 1975).

Table 3.2 Clothing of the army

Type of Goods	Need of Army	Distributed on May-July 1922	Remaining Need
Military Coats	95,114	1,900	83,214
Jackets	85,596	18,066	67,530
Pants	89,476	37,166	53,210
Underpants	358,826	79,000	289,826
Shirts	357,384	78,500	278,884
Portable tents	144,783	6,636	138,047

Ordnance depots mainly store weapons. To attack, Turkish Army need to have at least equal number of weapons with the enemy. During the Great Assault preparation period, flow of weapons to Western Front was speeded up. Machine guns and artillery coming from Elcezire Front, Eastern Front, İstanbul Ordnance Depots and even weapons purchased from foreign countries were stored in ordnance depots and then dispatched to Western Front.

As of July 1922, the number of weapons in Western Front reached to desired numbers. It reached to 106,630 rifles, 870 heavy machine guns and 316 artilleries. A significant incident was on July 1922; 1,500 machine guns were bought from France and suddenly machine gun number raised to 2,092. Machine gun is powerful for firing factors. Those machine guns were distributed to troops before Great Assault (Timur et al. 1975).

There were various types and model rifles in Turkish Army like Ottoman, English, German and Russian types. Different originated rifles were used up to 1922. So supply of spare parts and different ammunition of different originated rifles were big problems. During the Great Assault preparations, an arrangement has done about the handicap. Same type rifles were gathered in troops. This exchange of rifles also reasoned a trafficking in operational area (Timur et al. 1975).

Figure 3.5 Working women in an ordnance depot (İlkyazı, n.d.)

3.4 Ammunition Dumps

Ammunition Dumps store Class V supply. Providing ammunition for rifles and artilleries was a hot topic during Great Assault preparations. Because superior firepower is distinctive for the attack. Especially during Sakarya Battle, almost all the ammunition of Turkish Army was used. Ammunition deficiencies must be completed. Necessary measures were taken by Ministry of Defense and ammunition was transported from Istanbul depots, Elcezire Front, Eastern Front and from Soviet Russia to Western Front. Due to the daily use, there would be supply movement of ammunition from depots during Great Assault.

494,000 Ottoman bullets, 158,000 German bullets, 133,800 Russian bullets, 124,500 English bullets, 94,000 Mannlicher bullets and 192,700 French bullets were daily numbers of supply. And during the attack, it was 10 bullets per rifles and 100 bullets per machine guns for the average daily use. Also ammunition reserves were limited for an attack. There were only enough Ottoman bullets for two and a half day, enough German bullets for five days, enough Russian bullets for nine days, enough English bullets for sixty nine days, enough Mannlicher bullets for four days and enough French bullets for thirty three days (Timur et al. 1975).

To have a standpoint about the trafficking, amount of distributed ammunition from depots to Western Front by June 1922 (Timur et al. 1975):

Table 3.3 Distributed ammunition to Western Front

Infantry ammunition	4,427 ammo crates
Various artillery shells	55,300 shell shots
Grenades	13,640

3.5 Hospitals

Effectiveness of medical services is critically important during wartimes. In 1922, medical units were reorganized as a preparation for Great Assault. Dispersion of the hospitals on 01 July 1922 is showed in Figure 3.6.

Apart from the war casualties, contagious diseases were also a risk for the army. From time to time there were locally some examples of contagious patients. But with sensitive care and timely appropriate measures taken by the Turkish Army, the spread of contagious diseases were prevented. To be able to evaluate the density in hospitals; 165 officers and 17,042 privates were treated in one month period, in August 1922. Sixty percent of them were discharged from hospitals, eleven percent were sent back home to have a rest for a while, two percent were disarmed, seven percent were moved to other hospitals and approximately one percent of the patients were dead.

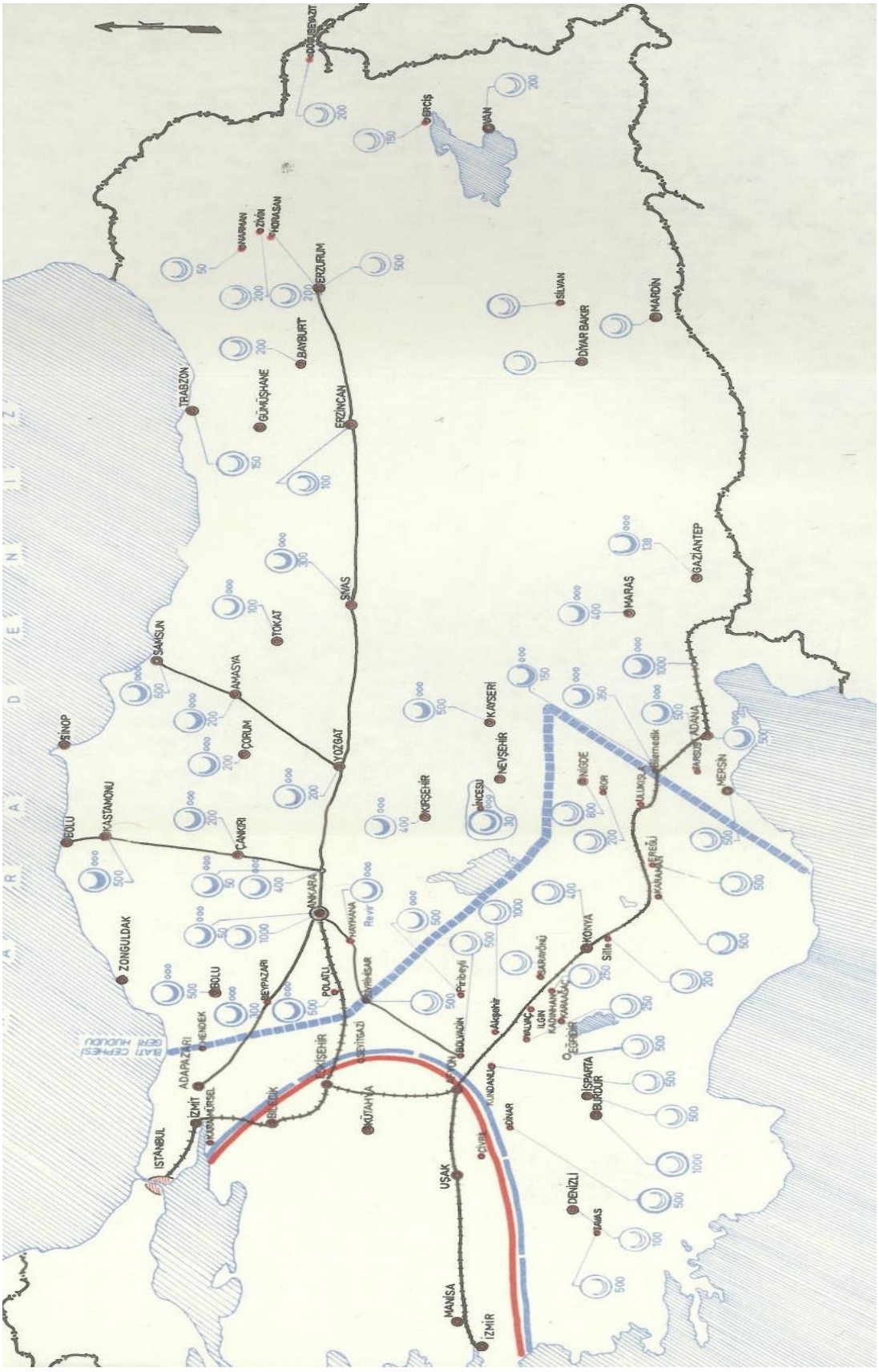


Figure 3.6 Dispersion of the hospitals on 01 July 1922 (Timur et al. 1975).

3.6 Convalescent Hospitals

To reduce patient density in hospitals; outpatient treatments, lengthy treatments, patients having weakness and need to have rest for a while for medical reasons were treated in convalescent hospitals. Food and accommodation were provided to patients during their medical treatments. The soldiers caught to contagious diseases as malaria, scabies, gonorrhea, syphilis were rehabilitated in convalescent hospitals.

Figure 3.7 A medical unit during The Independence War of Turkey (Ministry of Health, 2013)

3.7 Oil Depots

Oil Depots store Class III supply. In the first phases of The Independence War of Turkey, there was little petrol need due to the lack of motor vehicles. Mostly horse carriages were used instead. On June 1922 during the Great Assault preparations, 140 new trucks were bought from France and joined army. So in course of time needs to petroleum products increased. Oil need to be imported because in that time Turkey did not have the capability to produce oil. So Ministry of Defense imported petroleum products from foreign countries by sea. On June 1922, Ministry of Defense sent 243 tons gas, 473 kg vacuum oil, 1,095 kg grease oil to Western Front.

3.8 Coordinates of Logistic Points

XY coordinates for all the logistic points are included in the dataset at district level. The mean centers, standard distances, and standard deviational ellipses are derived, and the nearest neighbor analyses of the logistic points are conducted. The results of the analyses are in Chapter 4 Results.

By July 01, 1922 the locations as XY coordinates of the logistic points are below.

Table 3.4 XY coordinates of supply warehouses

LOCATIONS	X COORDINATE OF CENTROIDS	Y COORDINATE OF CENTROIDS
SEYHAN	35° 10' 44.329" E	36° 54' 45.946" N
BALA	33° 5' 45.348" E	39° 30' 33.910" N
BEYPAZARI	31° 55' 43.289" E	40° 8' 55.057" N
HAYMANA	32° 35' 36.835" E	39° 19' 6.669" N
KIZILCAHAMAM	32° 39' 49.311" E	40° 26' 37.193" N
KALECİK	33° 27' 18.140" E	40° 9' 30.759" N
NALLIHAN	31° 18' 59.138" E	40° 10' 54.336" N
POLATLI	32° 10' 9.548" E	39° 30' 53.058" N
GEREDE	32° 17' 21.928" E	40° 40' 39.008" N
GÖYNÜK	30° 49' 53.175" E	40° 21' 18.962" N
BOLU	31° 40' 23.311" E	40° 43' 14.635" N
ILGAZ	33° 41' 50.719" E	40° 55' 56.443" N
ÇANKIRI	33° 46' 19.376" E	40° 31' 13.778" N
ALACA	34° 54' 41.210" E	40° 9' 32.380" N
ÇORUM	34° 52' 31.688" E	40° 29' 23.108" N
SUNGURLU	34° 19' 21.634" E	40° 11' 42.269" N
DÜZCE	31° 15' 37.513" E	40° 53' 27.118" N
MİHALGAZİ	30° 36' 56.514" E	40° 0' 44.107" N
SARICAKAYA	30° 42' 44.882" E	40° 5' 40.039" N
K. MARAŞ	36° 50' 52.688" E	37° 39' 48.407" N
KAZIMKARABEKİR	32° 47' 33.302" E	37° 4' 15.331" N
İNEBOLU	33° 43' 5.839" E	41° 54' 46.760" N
KASTAMONU	33° 51' 32.969" E	41° 18' 41.454" N
İNCESU	35° 12' 48.462" E	38° 41' 17.458" N
MELİKGAZİ	35° 27' 46.300" E	38° 44' 23.525" N
KESKİN	33° 41' 44.841" E	39° 35' 9.692" N
YAHŞİHAN	33° 24' 27.872" E	39° 42' 40.023" N
KIRŞEHİR	34° 9' 6.446" E	39° 8' 33.972" N

Table 3.4 XY coordinates of supply warehouses cont

LOCATIONS	X COORDINATE OF CENTROIDS	Y COORDINATE OF CENTROIDS
KOCAELİ	30° 2' 43.673" E	40° 46' 33.806" N
SARAYÖNÜ	32° 27' 35.553" E	38° 22' 38.549" N
YUNAK	32° 4' 34.180" E	38° 46' 0.094" N
MERSİN	34° 25' 34.547" E	36° 57' 32.837" N
TARSUS	34° 49' 8.610" E	37° 3' 35.060" N
HACIBEKTAŞ	34° 39' 8.234" E	39° 0' 38.818" N
NİĞDE	34° 48' 41.447" E	38° 9' 54.370" N
ULUKIŞLA	34° 38' 47.384" E	37° 33' 42.382" N
OSMANİYE	36° 20' 56.059" E	37° 3' 19.863" N
GEYVE	30° 19' 14.812" E	40° 30' 34.204" N
HENDEK	30° 46' 36.850" E	40° 48' 14.694" N
SAKARYA	30° 26' 36.079" E	40° 47' 57.994" N
TARAKLI	30° 32' 46.790" E	40° 26' 33.863" N
HAVZA	35° 44' 12.796" E	41° 3' 54.945" N
SAMSUN	36° 13' 4.886" E	41° 14' 27.314" N
SİVAS	36° 58' 10.465" E	39° 41' 21.777" N
ÇEKEREK	35° 30' 35.231" E	40° 0' 51.275" N
YOZGAT	34° 49' 9.860" E	39° 49' 19.676" N

Table 3.5 XY coordinates of main supply route commands

LOCATIONS	X COORDINATE OF CENTROIDS	Y COORDINATE OF CENTROIDS
ADANA	35° 10' 44.329" E	36° 54' 45.946" N
BOLU	31° 40' 23.311" E	40° 43' 14.635" N
ÇORUM	34° 52' 31.688" E	40° 29' 23.108" N
KASTAMONU	33° 51' 32.969" E	41° 18' 41.454" N

Table 3.6 XY coordinates of ordnance depots

LOCATIONS	**X COORDINATE OF CENTROIDS**	**Y COORDINATE OF CENTROIDS**
POLATLI	32° 10' 9.548" E	39° 30' 53.058" N
ÇANKIRI	33° 46' 19.376" E	40° 31' 13.778" N
ÇORUM	34° 52' 31.688" E	40° 29' 23.108" N
İNEBOLU	33° 43' 5.839" E	41° 54' 46.760" N
KASTAMONU	33° 51' 32.969" E	41° 18' 41.454" N
GEYVE	30° 19' 14.812" E	40° 30' 34.204" N

Table 3.7 XY coordinates of ammunition dumps

LOCATIONS	**X COORDINATE OF CENTROIDS**	**Y COORDINATE OF CENTROIDS**
YUNAK	38° 18' 49.684" E	33° 40' 41.331" N
ÇANKAYA (ANKARA)	37° 14' 12.588" E	34° 29' 2.406" N
ÇORUM	36° 42' 58.820" E	36° 33' 3.532" N
YOZGAT	37° 22' 50.962" E	36° 27' 55.517" N
ÇANKIRI	36° 38' 12.428" E	35° 27' 0.012" N
MELİKGAZİ (KAYSERİ)	38° 29' 25.830" E	37° 3' 37.227" N
KASTAMONU	35° 51' 1.424" E	35° 34' 19.347" N
SIVAS	37° 36' 31.022" E	38° 36' 27.382" N
POLATLI	37° 34' 14.204" E	33° 48' 15.572" N
SAMSUN	36° 1' 31.200" E	37° 55' 31.692" N
NALLIHAN	36° 51' 59.371" E	32° 58' 54.462" N
İNEBOLU	35° 14' 35.792" E	35° 27' 28.559" N
SUNGURLU	36° 59' 10.531" E	35° 59' 8.471" N
ULUKIŞLA	39° 37' 52.727" E	36° 11' 33.462" N
KALECIK	36° 59' 3.655" E	35° 7' 2.218" N

Table 3.8 XY coordinates of hospitals

LOCATIONS	**X COORDINATE OF CENTROIDS**	**Y COORDINATE OF CENTROIDS**
POZANTI	34° 59' 3.486" E	37° 32' 47.338" N
SEYHAN	35° 10' 44.329" E	36° 54' 45.946" N
AMASYA	35° 53' 50.335" E	40° 36' 29.899" N
BEYPAZARI	31° 55' 43.289" E	40° 8' 55.057" N
POLATLI	32° 10' 9.548" E	39° 30' 53.058" N
GÖYNÜK	30° 49' 53.175" E	40° 21' 18.962" N
BOLU	31° 40' 23.311" E	40° 43' 14.635" N
ÇANKIRI	33° 46' 19.376" E	40° 31' 13.778" N
ÇORUM	34° 52' 31.688" E	40° 29' 23.108" N
ŞEHİTKAMİL	37° 20' 52.990" E	37° 10' 52.432" N
K.MARAŞ	36° 50' 52.688" E	37° 39' 48.407" N
KASTAMONU	33° 51' 32.969" E	41° 18' 41.454" N
MELİKGAZİ	35° 27' 46.300" E	38° 44' 23.525" N
YAHŞİHAN	33° 24' 27.872" E	39° 42' 40.023" N
SARAYÖNÜ	32° 27' 35.553" E	38° 22' 38.549" N
TARSUS	34° 49' 8.610" E	37° 3' 35.060" N
BOR	34° 33' 59.888" E	37° 51' 21.111" N
NİĞDE	34° 48' 41.447" E	38° 9' 54.370" N
ULUKIŞLA	34° 38' 47.384" E	37° 33' 42.382" N
SAMSUN	36° 13' 4.886" E	41° 14' 27.314" N
SİVAS	36° 58' 10.465" E	39° 41' 21.777" N
TOKAT	36° 35' 56.378" E	40° 16' 14.908" N
YOZGAT	34° 49' 9.860" E	39° 49' 19.676" N

Table 3.9 XY coordinates of convalescent hospitals

LOCATIONS	**X COORDINATE OF CENTROIDS**	**Y COORDINATE OF CENTROIDS**
DÖRTYOL	36° 17' 58.897" E	36° 49' 15.722" N
AMASYA	35° 53' 50.335" E	40° 36' 29.899" N
KASTAMONU	33° 51' 32.969" E	41° 18' 41.454" N
MELİKGAZİ	35° 27' 46.300" E	38° 44' 23.525" N
SAMSUN	36° 13' 4.886" E	41° 14' 27.314" N
SİVAS	36° 58' 10.465" E	39° 41' 21.777" N
YOZGAT	34° 49' 9.860" E	39° 49' 19.676" N

Table 3.10 XY coordinates of oil depots

LOCATIONS	**X COORDINATE OF CENTROIDS**	**Y COORDINATE OF CENTROIDS**
İNEBOLU	33° 43' 5.839" E	41° 54' 46.760" N
TARSUS	34° 49' 8.610" E	37° 3' 35.060" N
SAMSUN	36° 13' 4.886" E	41° 14' 27.314" N

CHAPTER FOUR
ANALYSIS AND RESULTS

In this study, spatial analyses are categorized under three headings:

(1) measuring central tendency,
(2) measuring dispersion,
(3) measuring distribution.

In this chapter, the data locations (XY coordinates), the mean centers, standard distances, standard deviational ellipses, and the nearest neighbor analyses of selected logistic points are presented with the help of a vector GIS. As to remember, the examined logistic points are given below:

- Main supply route commands,
- Supply warehouses,
- Ordnance depots,
- Ammunition dumps,
- Hospitals,
- Convalescent hospitals,
- Oil depots.

The results for each logistic point are explained in order by these titles.

4.1 Main Supply Route Commands

By 01 July 1922, there were four main supply route commands under the directory of General Directorate of Shipping and Transportation. Their locations were settled in provinces and each point has its own responsibility area to manage shipping and transportation. They are directly connected to the General Directorate of Shipping and Transportation in Ankara. Bolu command is on the way to İstanbul roadway supply route and its responsibility area covers western part. Kastamonu command is on the way to the İnebolu Port supply route and its responsibility area

covers the northern part. Çorum command is on the way to the Samsun Port and Eastern Front supply route and its responsibility area covers the eastern part. And finally Adana command is on the way to the Southern Front supply route and its responsibility area covers the southern part. So the whole main supply responsibility area is divided into parts. Normally this division makes the point locations a bit far away to each other. In all the layouts, legends are given on the right corner having the key of logistic points, mean centers, standard distances and standard deviational ellipses. TUR_adm2 layer is the Turkey administrative county border map.

In Figure 4.1 Main Supply Route Commands locations and the analyses are presented.

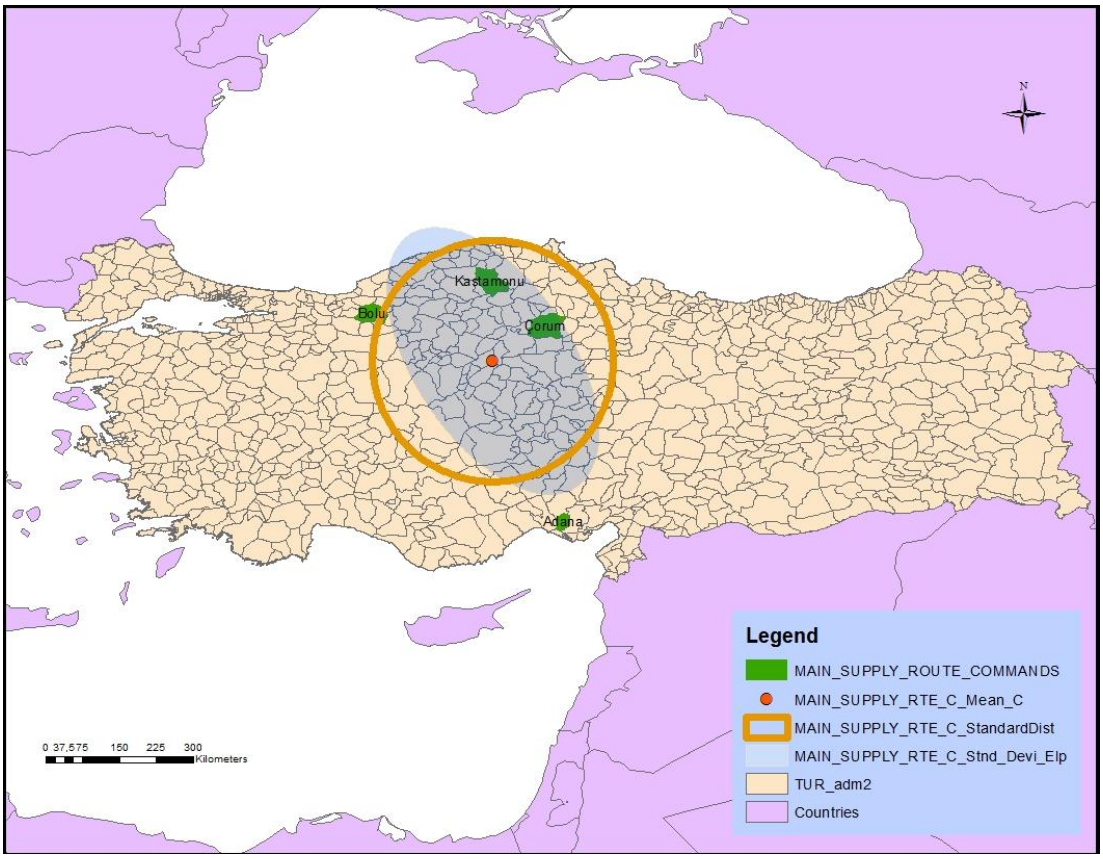


Figure 4.1 The layout of main supply route commands analyses

The XY coordinates values of mean centre are below in Table 4.1 and the layout is above in Figure 4.1. The mean centre is near Delice district of Kırıkkale province. It is approximately in the middle of Anatolia and a close location to Ankara.

Table 4.1 XY coordinates of main supply route commands mean centre

MEAN CENTRE	X COORDINATE	Y COORDINATE
Main supply route commands mean centre	33.896702	39.8587

The standard distance value of main supply route commands is 2.20 DD (244 km). The standard deviational ellipse represents the dispersion in two dimensions and the direction of the distribution. The standard directional ellipse parameters for the main supply route commands are as follows:

Centre X : 33.896687
Centre Y : 39.858691
X Standard Distance : 2.767554
Y Standard Distance : 1.442165
Rotation : 146.562805

The layout of visualized Standard Distance and Standard Deviational Ellipse of main supply route commands in Arcgis is above in Figure 4.1.

The average nearest neighbor distance for the observed data is 2.117, and the expected mean distance is 0.844. Nearest neighbor ratio is 2.509. The pertaining z-statistics is 5.777, and the null hypothesis that the observed point data distribution is random can be rejected at the 0.05 significance level. The results from the nearest neighborhood analyses indicate that the observed point distribution is a dispersed pattern. For the distribution of main supply route commands, there is less than 1% likelihood that this dispersed pattern could be the result of random chance.

4.2 Supply Warehouses

By 01 July 1922, there are forty six supply warehouses under the directory of General Directorate of Shipping and Transportation. They gather and store foodstuff. During the preparations of Great Assault, supply warehouses were settled mostly

close areas to agricultural lands and Western Front to make the transportation time less because the army needs daily foodstuff supply.

In Figure 4.2 Supply Warehouses locations and the results of the analyses are presented.

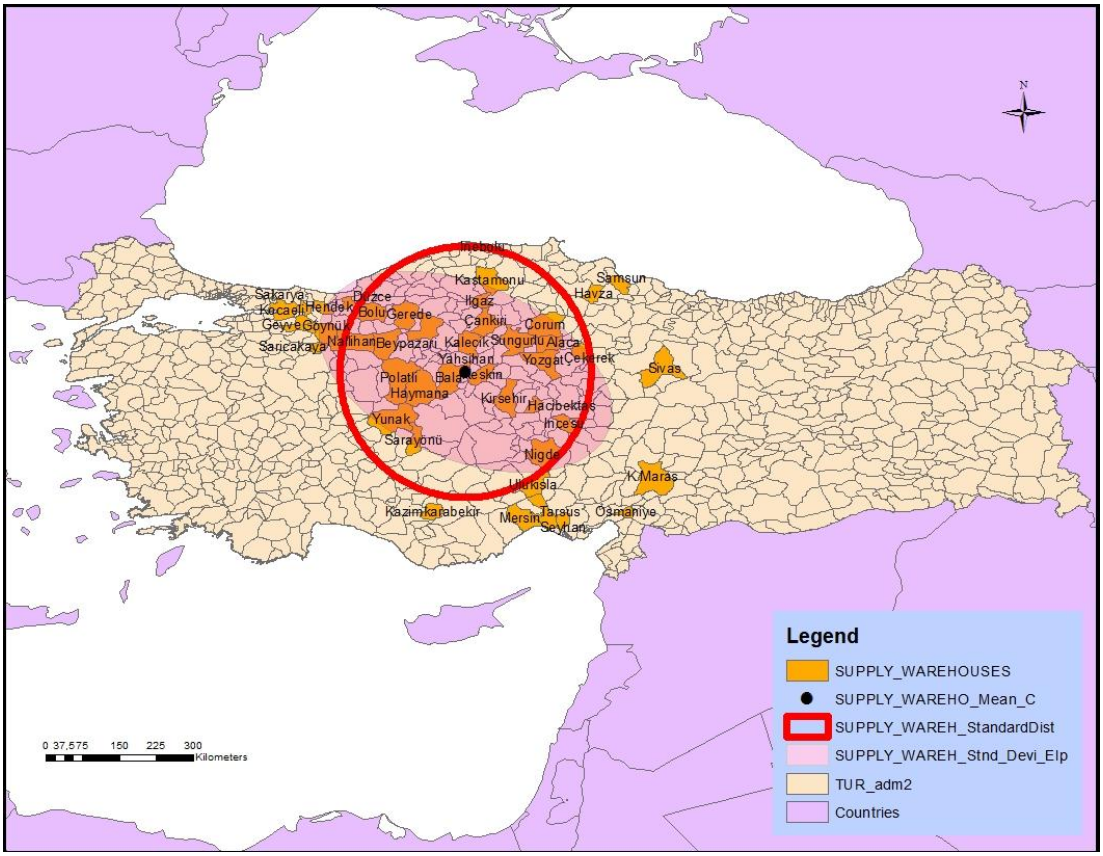


Figure 4.2 The layout of supply warehouses analyses

The XY coordinates values of mean center are below in Table 4.2 and the layout is above in Figure 4.2. The mean centre is at Yahşihan district of Kırıkkale province. Yahşihan as a location is neither too far nor too close to the Western Front with an optimum distance. Also it is an important intersection of transportation routes.

Table 4.2 XY coordinates of supply warehouses mean centre

MEAN CENTRE	X COORDINATE	Y COORDINATE
Supply warehouses mean centre	33.394299	39.634403

The standard distance value of supply warehouses is 2.30 DD (255 km). The standard deviational ellipse represents the dispersion in two dimensions and the direction of the distribution. The standard directional ellipse parameters for the supply warehouses are as follows:

Centre X : 33.394348
Centre Y : 39.634402
X Standard Distance : 2.830883
Y Standard Distance : 1.605279
Rotation : 112.654138

The layout of visualized Standard Distance and Standard Deviational Ellipse of supply warehouses in Arcgis is above in Figure 4.2.

The average nearest neighbor distance for the observed data is 0.475, and the expected mean distance is 0.430. Nearest neighbor ratio is 1.102. The pertaining z-statistics is 1.329, and the null hypothesis that the observed point data distribution is random cannot be rejected. It is the only spatial pattern with random distribution among all the logistic points.

4.3 Ordnance Depots

By 01 July 1922, there were six ordnance depots under the directory of General Directorate of Shipping and Transportation. İstanbul had the biggest ordnance depots of Ottoman Army so it was a good resource of supply for the Turkish Army. The ordnance, in high tonnages, is transported from İstanbul depots to İnebolu Port by sea. It is distributed from İnebolu depot to Kastamonu and Çankırı depots. İnebolu Port appears to be a remarkable loading point for ordnance supply with the convenient characteristics. Çorum had also a depot to store the ordnance shipped to Samsun Port. Geyve district had another depot. It is on the way of İstanbul transportation route. There is a depot in Polatlı as well. It is in a close distance to the front and there is a railway between Ankara and Polatlı. Transportation to the

Western Front is done from Polatlı and Geyve depots with the advantage of the railway network.

In Figure 4.3 Ordnance Depots locations and the analyses are presented.

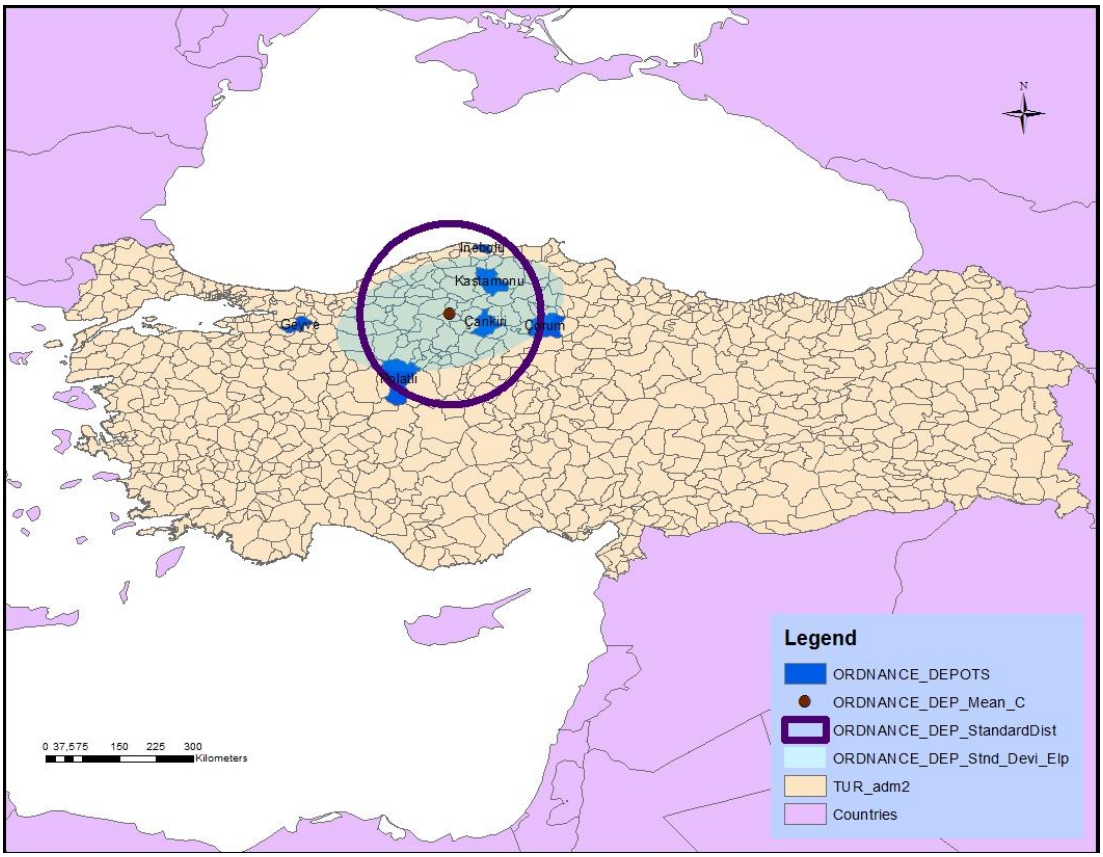


Figure 4.3 The layout of ordnance depots analyses

The XY coordinates values of mean centre are below in Table 4.3. The layout is above in Figure 4.3. The mean centre is between Atkaracalar and Orta districts of Çankırı province. It is close to İnebolu, Kastamonu and Çankırı depots because of the concentrated distribution of ordnance depots in that area.

Table 4.3 XY coordinates of ordnance depots mean centre

MEAN CENTRE	X COORDINATE	Y COORDINATE
Ordnance depots mean centre	33.119202	40.709801

The standard distance value of ordnance depots is 1.65 DD (183 km). This value shows that the distribution of ordnance depots has the most concentrated distribution among other logistic points with the smallest standard distance circle.

The standard deviational ellipse represents the dispersion in two dimensions and the direction of the distribution. The standard directional ellipse parameters for the ordnance depots are as follows:

Centre X : 33.119177
Centre Y : 40.709832
X Standard Distance : 0.970667
Y Standard Distance : 2.135904
Rotation : 77.167569

The layout of visualized Standard Distance and Standard Deviational Ellipse of ordnance depots in Arcgis is above in Figure 4.3.

The average nearest neighbor distance for the observed data is 1.188, and the expected mean distance is 0.555. Nearest neighbor ratio is 2.141. The pertaining z-statistics is 5.348, and the null hypothesis that the observed point data distribution is random can be rejected at the 0.05 significance level. The results from the nearest neighborhood analyses indicate that the observed point distribution is a dispersed pattern. For the distribution of ordnance depots, there is less than 1% likelihood that this dispersed pattern could be the result of random chance.

4.4 Ammunition Dumps

By 01 July 1922, there were fifteen ammunition dumps under the directory of General Directorate of Shipping and Transportation. The locations having ordnance depots, except Geyve district, also have ammunition dumps. The ammunition, in high tonnages, is transported from Soviet Russia and Eastern Front to Samsun Port

and transported to Çorum and Yozgat depots. İnebolu is another important port for ammunition transported from İstanbul.

In Figure 4.4 Ammunition Dumps locations and the analyses are presented.

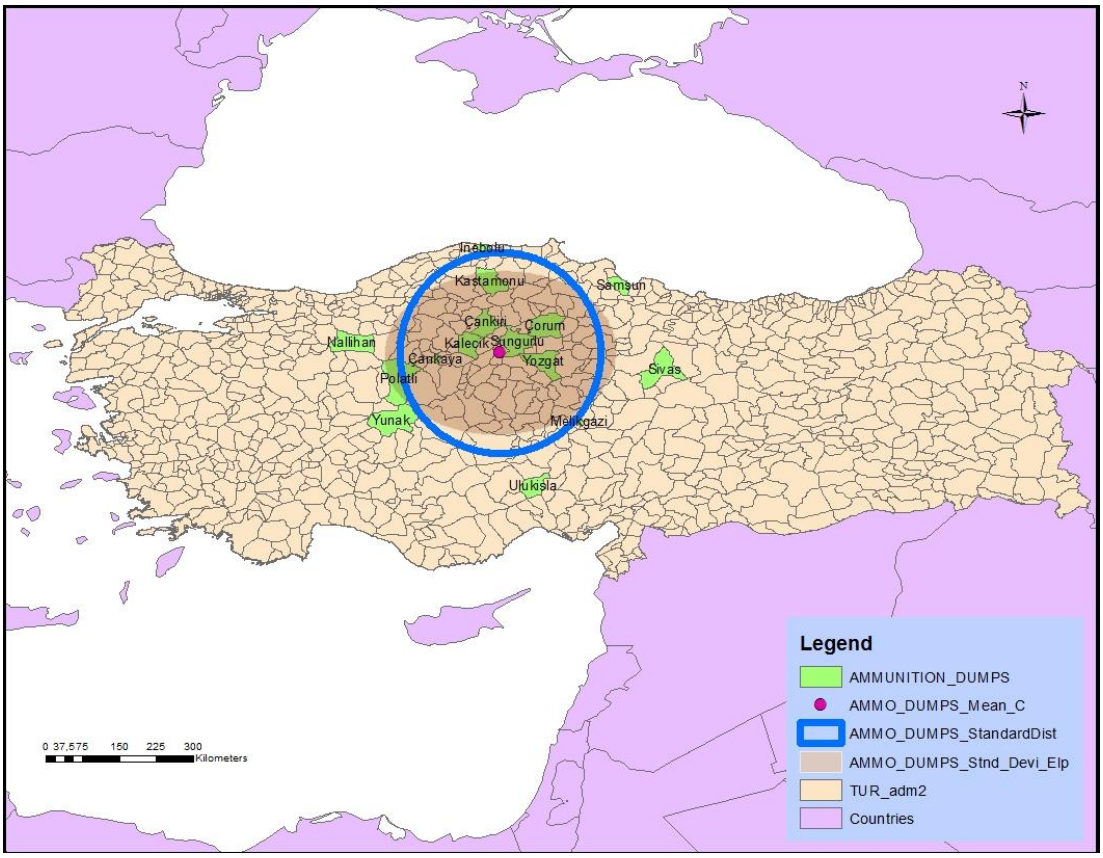


Figure 4.4 The layout of ammunition dumps analyses

The XY coordinates values of mean centre are below in Table 4.4 and the layout is above in Figure 4.4. Most of the ammunition dumps are on Samsun-Yahşihan route and İnebolu-Ankara route. The mean is in the middle of these routes. The mean centre is at Delice district of Kırıkkale. Ammunition supply needs time scheduling. When ammos are used in the battle, they must be supplied very quickly and on time. Depots need to be close to main supply routes and in proper distances neither close nor remote to the front. So there is a point concentration around mean center. Ammunition dumps are generally on the arterial roads and railways because as ordnance equipments, ammunition is very heavy to transport.

Table 4.4 XY coordinates of ammunition dumps mean centre

MEAN CENTRE	X COORDINATE	Y COORDINATE
Ammunition dumps mean centre	34.034302	39.998901

The standard distance value of ammunition dumps is 1.84 DD (204 km). The standard deviational ellipse represents the dispersion in two dimensions and the direction of the distribution. The standard directional ellipse parameters for the ammunition dumps are as follows:

Centre X : 34.034300
Centre Y : 39.998928
X Standard Distance : 1.502275
Y Standard Distance : 2.126521
Rotation : 87.489767

The layout of visualized Standard Distance and Standard Deviational Ellipse of ammunition dumps in Arcgis is above in Figure 4.4.

The average nearest neighbor distance for the observed data is 0.886, and the expected mean distance is 0.571. Nearest neighbor ratio is 1.551. The pertaining z-statistics is 4.086, and the null hypothesis that the observed point data distribution is random can be rejected at the 0.05 significance level. The results from the nearest neighborhood analyses indicate that the observed point distribution is a dispersed pattern. For the distribution of ammunition dumps, there is less than 1% likelihood that this dispersed pattern could be the result of random chance.

4.5 Hospitals

On 01 July 1922, there were twenty three hospitals under the directory of General Directorate of Shipping and Transportation. The main idea for the Great Assault was that the Turkish Army would attack to south part of the Greek Army. So the preparations to care of wounded soldiers in the war would be held mainly in Adana

and Konya regions in the south. New hospitals were established and capacities of old ones were increased. The hospital density in Adana neighborhood is remarkable by 01 July 1922.

In Figure 4.5 Hospitals locations and the analyses are presented.

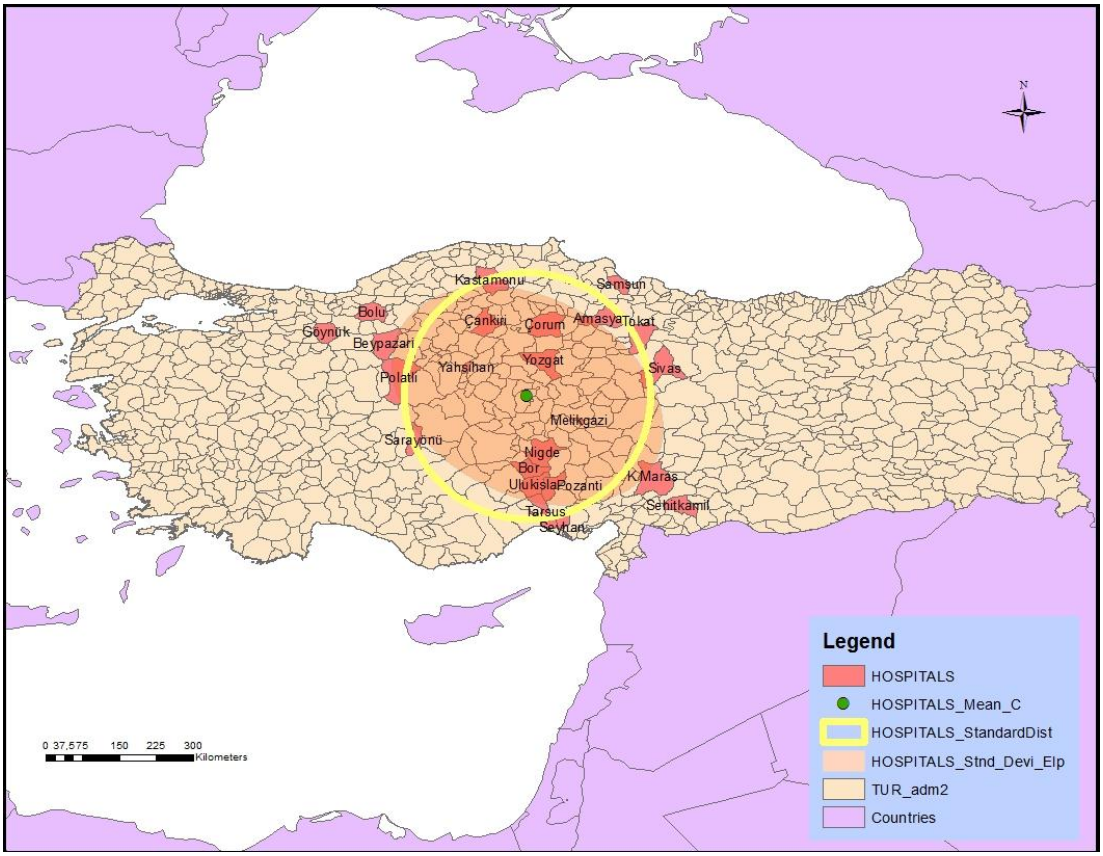


Figure 4.5 The layout of hospitals analyses

The XY coordinates values of mean centre are below in Table 4.5 and the layout is above in Figure 4.5. The mean centre is at Mucur district of Kırşehir province. The hospital density in Adana region makes the mean centre close to this area.

Table 4.5 XY coordinates of hospitals mean centre

MEAN CENTRE	X COORDINATE	Y COORDINATE
Hospitals mean centre	34.528099	39.194199

The standard distance value of hospitals is 2.25 DD (250 km). For each point it is the standard deviation of distance from the mean center. With bigger standard

distance circle, the value highlights one of less concentration. This result makes dispersed distribution but a lower level according to other dispersed logistic points.

The standard deviational ellipse represents the dispersion in two dimensions and the direction of the distribution. The standard directional ellipse parameters for the hospitals are as follows:

Centre X : 34.528090
Centre Y : 39.194236
X Standard Distance : 2.626988
Y Standard Distance : 1.809607
Rotation : 116.783175

The layout of visualized Standard Distance and Standard Deviational Ellipse of hospitals in Arcgis is above in Figure 4.5.

The average nearest neighbor distance for the observed data is 0.653, and the expected mean distance is 0.547. Nearest neighbor ratio is 1.194. The pertaining z-statistics is 1.194, and the null hypothesis that the observed point data distribution is random can be rejected at the 0.10 significance level. The results from the nearest neighborhood analyses indicate that the observed point distribution is a dispersed pattern. For the distribution of hospitals, there is less than 10% likelihood that this dispersed pattern could be the result of random chance.

4.6 Convalescent Hospitals

By 01 July 1922, there are seven convalescent hospitals under the directory of General Directorate of Shipping and Transportation. Convalescent hospitals are located distant to Western Front. Considering convalescent hospitals are for lengthy treatments and for patients having weakness, thus being distant from operational areas is quite normal for convalescent hospitals.

Kastamonu, Samsun, Yozgat, Amasya, Sivas and Kayseri provinces have both hospitals and convalescent hospitals together, it is reasonable because convalescent hospitals provide complementary medical treatment of hospitals. Only Dörtyol city has a convalescent hospital but no hospital. Dörtyol convalescent hospital is established to support six Adana region hospitals.

In Figure 4.6 Convalescent Hospitals locations and the analyses are presented.

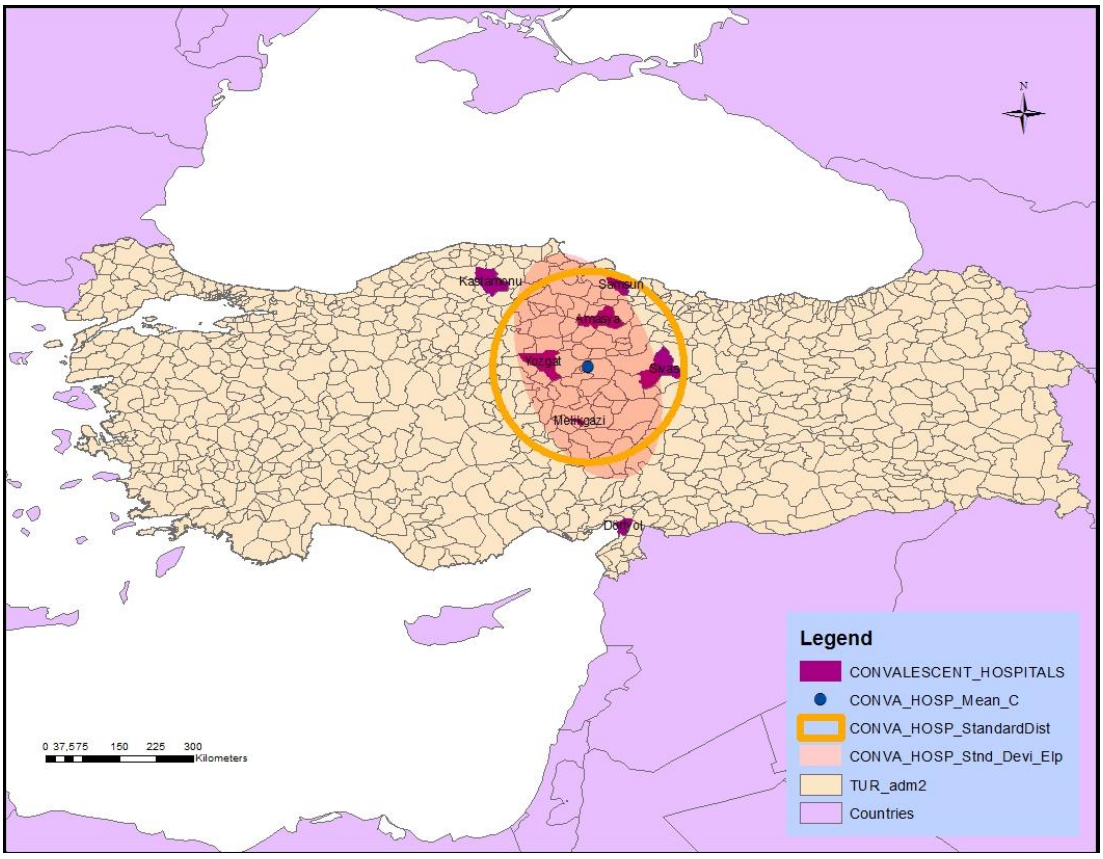


Figure 4.6 The layout of convalescent hospitals analyses

The XY coordinates values of mean centre are below in Table 4.6 and the layout is above in Figure 4.6. The mean centre is at Akdağmadeni district of Yozgat province. Though it is close to mean center of hospitals, it is clearly remote to Western Front. Turkish Army used east as the rear area and convalescent hospitals settle in rear areas, so the mean centre of convalescent hospitals is the most eastern mean centre among all other logistic points.

Table 4.6 XY coordinates of convalescent hospitals mean centre

MEAN CENTRE	X COORDINATE	Y COORDINATE
Convalescent hospitals mean centre	35.646599	39.747601

The standard distance value of convalescent hospitals is 1.75 DD (194 km). The value indicates one of the most concentrated logistic points with a small standard distance circle. That is because the number of convalescent hospitals is limited and they are relatively close each other.

The standard deviational ellipse represents the dispersion in two dimensions and the direction of the distribution. The standard directional ellipse parameters for the convalescent hospitals are as follows:

Centre X : 35.646576
Centre Y : 39.747594
X Standard Distance : 2.159154
Y Standard Distance : 1.215170
Rotation : 159.945966

The layout of visualized Standard Distance and Standard Deviational Ellipse of convalescent hospitals in Arcgis is above in Figure 4.6.

The average nearest neighbor distance for the observed data is 1.316, and the expected mean distance is 0.610. Nearest neighbor ratio is 2.157. The pertaining z-statistics is 5.860, and the null hypothesis that the observed point data distribution is random can be rejected at the 0.05 significance level. The results from the nearest neighborhood analyses indicate that the observed point distribution is a dispersed pattern. For the distribution of convalescent hospitals, there is less than 1% likelihood that this dispersed pattern could be the result of random chance.

4.7 Oil Depots

By 01 July 1922, there were three oil depots under the directory of General Directorate of Shipping and Transportation. There were no oil production in Turkey in that time so oil had to be imported from foreign countries and this could be only by maritime transportation. Samsun and İnebolu cities coast to the Black Sea in the north and Mersin city coasts to Mediterranean Sea in the south. They are the biggest and active ports of the time, which were not under occupation of the allied countries. With the help of these ports, İnebolu and Samsun depots stored oil imported from Soviet Russia, and Mersin depot stored oil imported from European countries.

In Figure 4.7 Oil Depots locations and the analyses are presented.

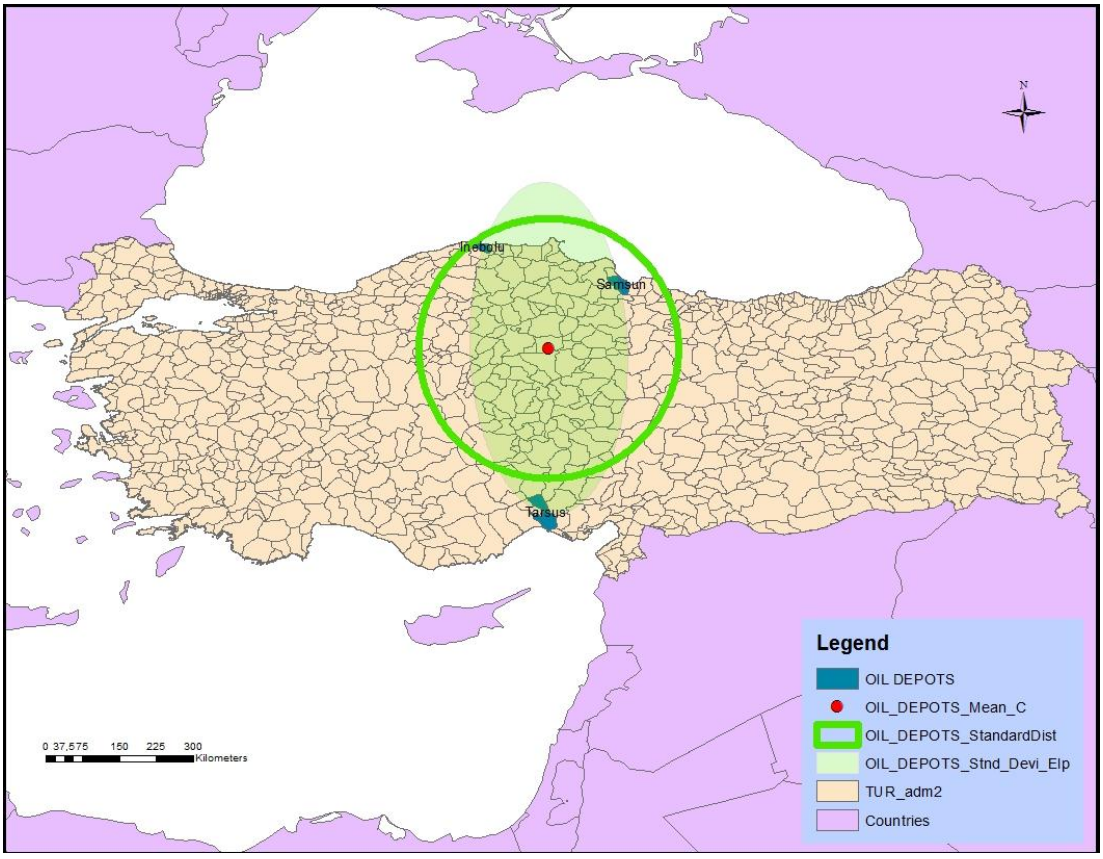


Figure 4.7 The layout of oil depots analyses

The XY coordinates values of mean centre are below in Table 4.7 and the layout is above in Figure 4.7. The mean centre is at Yozgat province. The mean centre of the distribution is in middle Anatolia because two of the points are in northern border

and one of the points is in the southern border. Their locations are distant to each other in north south line.

Table 4.7 XY coordinates of oil depots mean centre

MEAN CENTRE	X COORDINATE	Y COORDINATE
Oil depots mean centre	34.918499	40.071201

The standard distance value of oil depots is 2.37 DD (263 km). Logistic points are generally located to connect each other. Some are on the same supply route, some are on the same line, some are concentrated in the west, some are concentrated in the east, some are close to resources, and some are located in the rear areas with the bigger standard distance values. However, the distribution of oil depots is different. Their common characteristic is being closer to the harbors. Thus, for the oil depots the standard distance value is relatively high.

The standard deviational ellipse represents the dispersion in two dimensions and the direction of the distribution. The standard directional ellipse parameters for the Oil Depots are as follows:

Centre X : 34.918457
Centre Y : 40.071216
X Standard Distance : 3.037939
Y Standard Distance : 1.443347
Rotation : 177.908140

The layout of visualized Standard Distance and Standard Deviational Ellipse of oil depots in Arcgis is above in Figure 4.7.

The average nearest neighbor distance for the observed data is 3.195, and the expected mean distance is 0.974. Nearest neighbor ratio is 3.279. The pertaining z-statistics is 3.279, and the null hypothesis that the observed point data distribution is random can be rejected at the 0.05 significance level. The results from the nearest

neighborhood analyses indicate that the observed point distribution is a dispersed pattern. For the distribution of oil depots, there is less than 1% likelihood that this dispersed pattern could be the result of random chance.

CHAPTER FIVE
CONCLUSION

The main aim in installing logistic points is to secure, store and transport the logistics on time with appropriate amounts. The selection of locations is very important to achieve these aims. According to the results presented in Chapter 4, locational choices regarding the logistic points are far from being random in The Independence War of Turkey. Closeness to transportation networks and resources were considered. Locational choices were made to obtain a dispersed distribution of logistic points to operational area.

There were four main routes for transporting logistics like weapons, ammunition, food, ordnance and oil during the preparations of Great Assault.
On November 12, 1921 the routes were

- Kayseri – Kırşehir – Yahşihan (yellow line in Figure 5.1),
- İnebolu – Kastamonu – Çankırı – Kalecik – Ankara (red line in Figure 5.1),
- Samsun – Çorum - Yozgat – Yahşihan (gren line in Figure 5.1),
- İzmit – Ankara (blue line in Figure 5.1).

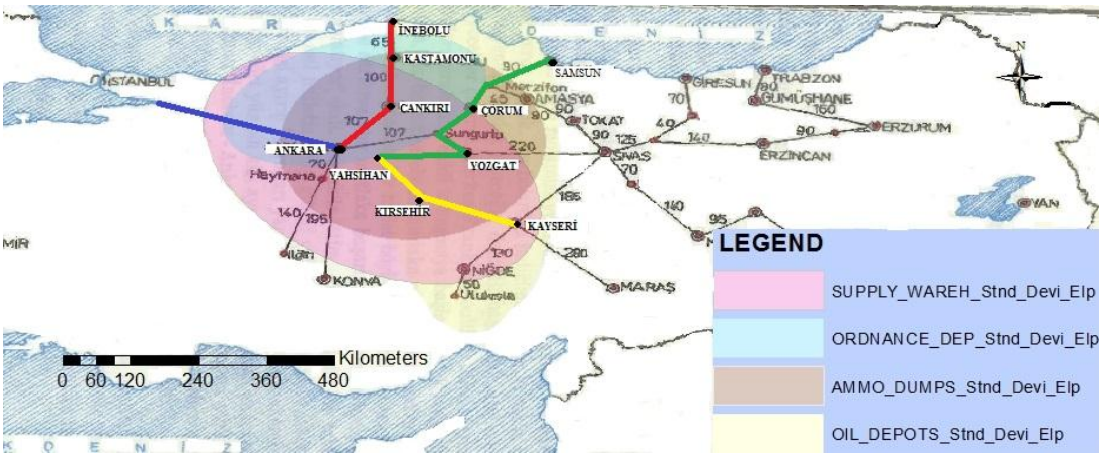


Figure 5.1 Standard deviational ellipses and roadway routes colored by lines (adopted from Timur et al. 1975).

As seen in Figure 5.1 above, these routes have the roadway networks and close to resources. Supply from Soviet Russian was distinctive for Turkish Army and with

convenient locations Samsun and İnebolu ports were chosen for ammunition, ordnance and oil supply. İzmit and Kayseri routes are close to fertile agricultural lands. So the foodstuff supply is mainly transported from İzmit and Kayseri routes while ammunition, ordnance and oil supply is transported from Samsun and İnebolu routes. Their common characteristics are to have roadway networks and accessibility to resources. The type and tonnages of cargos are shown in Figure 5.2 below.

Standard deviational ellipses show the direction of the distribution. In Figure 5.1, it is clear that standard deviational ellipses of supply warehouses, ordnance depots, ammunition dumps and oil depots are along these transportation roadways routes by the side of transported goods. Closeness to transportation networks and resources is a determinant for the location and distribution of logistic points.

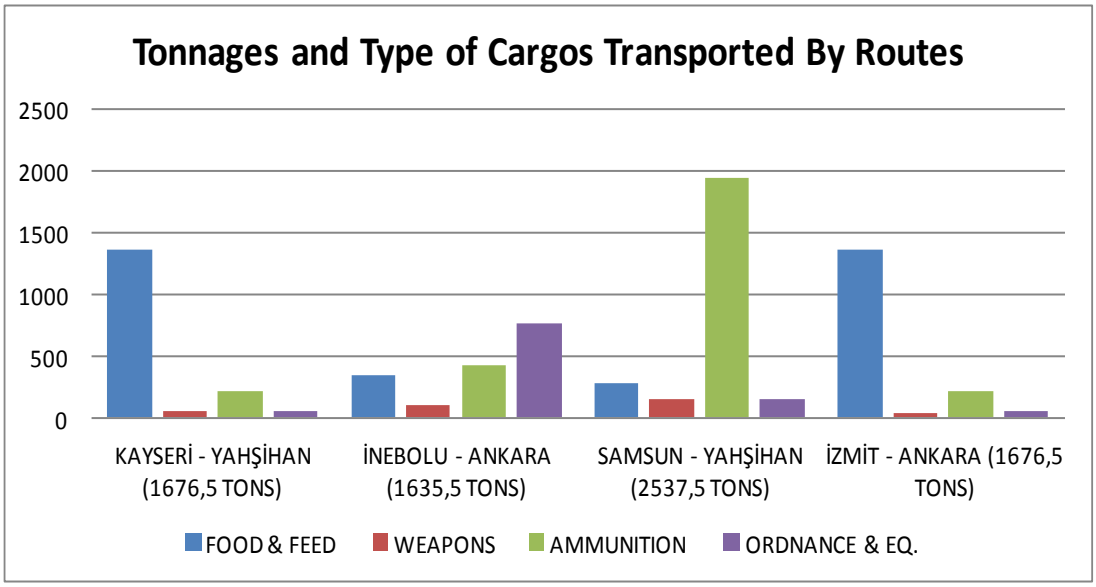


Figure 5.2 Transported cargos from routes 11 October 1921 - 31 July 1922 (Timur et al. 1975).

Railways are very strong force multiplier of the wars. Heavy supply equipments can be transported quickly and easily by the railways. They are one of the most significant determinants for selection logistic point location. But before the Great Assault some parts of the railways network were in enemy occupied regions. Also, the west part of the network is very close to operational area. So the logistic points of Turkish Army are generally located beyond the operational area. Here, the location of the capital city, Ankara, is remarkable. It is in the optimum distant to the fronts

and logistic points. Within the cities having railway access, it is the closest location to the mean centers of the logistic points. It is also the only city with railway access that resides within the standard distances of all logistic intersection points except the one for the convalescent hospitals. In Figure 5.3 the mean centers, standard distance circles, intersection of standard distance circles (with brown lines), railway network (with orange line) and enemy occupied regions (with yellow lines) before Great Assault are shown below. Remark that the case of convalescent hospitals is a bit different as they need to be in the rear area where the mean and standard distance are in the east. These advantages make Ankara as the assembly centre of logistics and decision making in the war. During the war, General Directorate of Shipping and Transportation is also settled in Ankara. And after the war on October 13, 1923 Ankara was found as the new capital city.

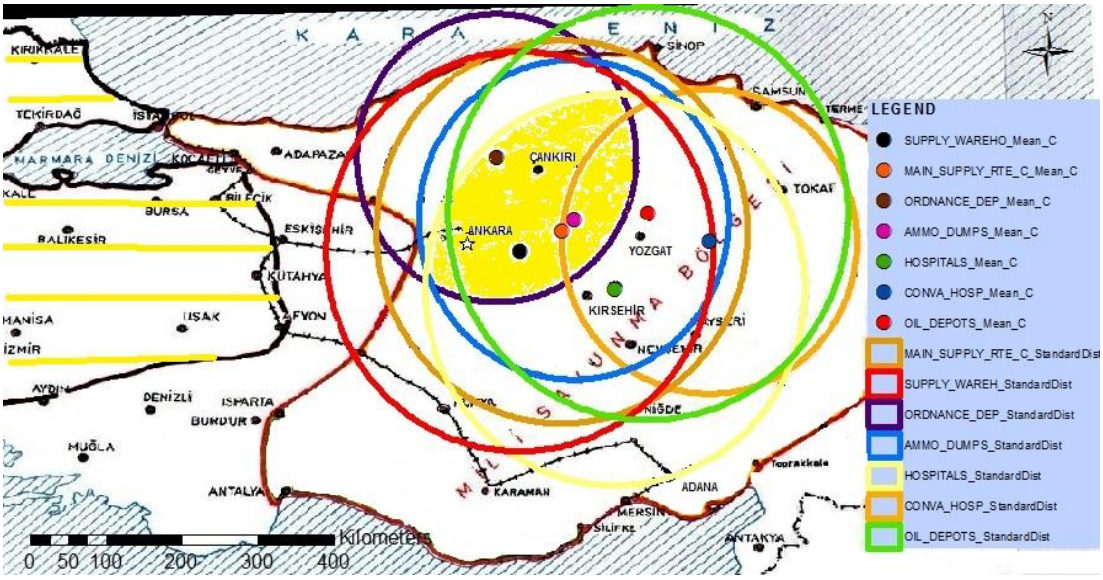


Figure 5.3 The mean centers and intersection of standard distance circles (adopted from Timur et al. 1975).

Before Great Assault, the requirements of the Western Front were top priority, because the opponent forces were deployed in western part of Anatolia. For a decisive triumph, there needs to be an effective logistic support, and for an effective logistic support, there needs to be well organized logistic points. One of the main purposes of locating logistic points in The Independence War of Turkey is to be in optimum distance to Western Front.

The results of the study show that, the mean centers of the logistic points are generally close to each other and in an optimum distance to the front. But logistic points do not have to be in the same distance to the fronts. In Figure 5.4 the mean centers of logistic points, enemy occupied regions (with brown lines) and national defending area (inside red borders) are shown.

Supply warehouses mean centre is found to be the closest to the front (Figure 5.4), because foodstuff supply is a daily supply. Even in preparation period army consumes food. Convalescent hospitals' mean centre is the furthest to the front (Figure 5.4), because they settle in rear area for lengthy treatments, patients having weakness and need to have rest for a while for medical reasons. Ordnance depots mean centre is the northernmost because half of the ordnance depots are on the İnebolu-Ankara route. Hospitals mean centre is the southernmost (Figure 5.4), because of new established hospitals for Great Assault in Adana region. Being so close to each other for supply warehouses, main supply route commands and ammunition dumps mean centers are also remarkable.

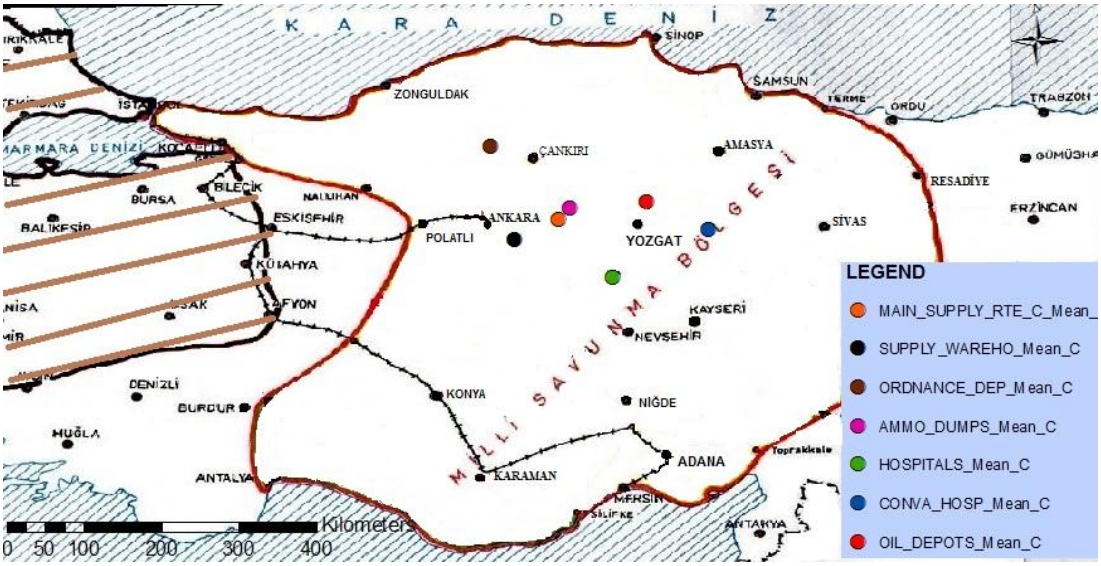


Figure 5.4 The mean centers of the logistic points (adopted from Timur et al. 1975).

Average nearest neighbor tool is very operative in comparing the distribution of different logistic points. In this study, total area is defined as the whole country and all the logistic points have dispersed patterns except supply warehouses. The western

regions are under enemy occupation, so all the logistic points locate in the east of Western Front. The Turkish Army used east, south and north parts of the country as backyards and installed logistic points in a spatially dispersed pattern. Remark that the spatial distribution is random, and this finding is statistically significant. At first to cluster the logistic points to an area which is close to the front sounds reasonable but it is not. In case of a withdrawal or an attack they can be destroyed by enemy. But a dispersed distribution gives the advantage of using a large area.

With the most number of points, supply warehouses have no sign of clustering or dispersion pattern. It is the only logistic point having random pattern. Because foodstuff has varied resources and needing of the army is daily. So it is stored wherever it is harvested and transported to the front frequently.

Main supply route commands, ordnance depots, ammunition dumps, oil depots, hospitals and convalescent hospitals show a dispersed or uniform pattern. These logistic points are distributed over the country with similar distances between outside the occupied. They are located taking into account the location of the resources and to transportation logistics on time with enough amounts.

After World War I, Turkish Nation and his Turkish Army needs a decisive and a complete victory to have their freedom back. Logistics is a vital part of it. Army needs food, ammunition, ordnance, oil and medical assistance even in preparation period. Resources are limited and transportation is a big problem. Under these circumstances, the Turkish Army needs a well organized logistic system. Closeness to transportation networks and resources were considered. Locational choices were made to obtain a dispersed distribution of logistic point to operational area. The results are such a proof that Turkish Army planned the logistic point distribution wisely and the success was not a coincidence.

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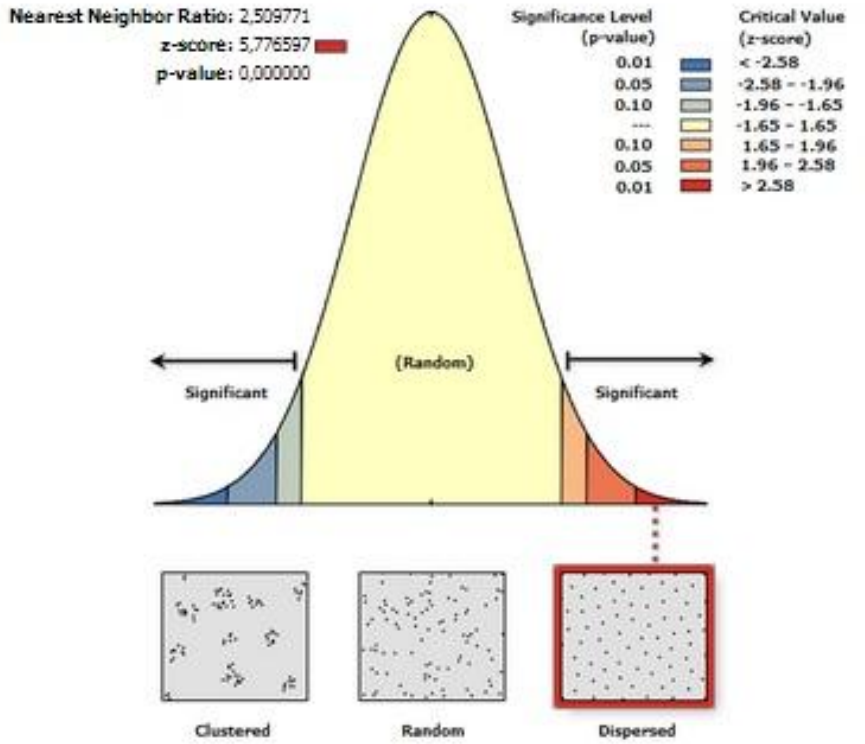
APPENDICES

Average Nearest Neighbor Summary



Given the z-score of 5.78, there is a less than 1% likelihood that this dispersed pattern could be the result of random chance.

Average Nearest Neighbor Summary

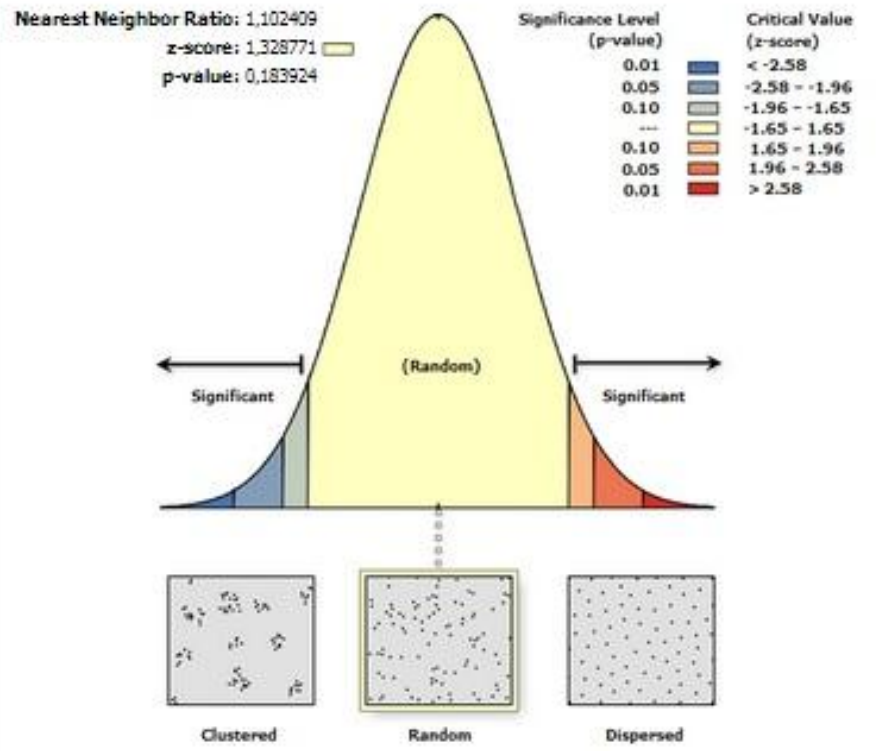
Observed Mean Distance:	2,117058
Expected Mean Distance:	0,843526
Nearest Neighbor Ratio:	2,509771
z-score:	5,776597
p-value:	0,000000

Dataset Information

Input Feature Class:	MENZIL_MINTIKA_K
Distance Method:	EUCLIDEAN
Study Area:	11,384584

Average Nearest Neighbor Summary of Main Supply Route Commands

Average Nearest Neighbor Summary



Given the z-score of 1.33, the pattern does not appear to be significantly different than random.

Average Nearest Neighbor Summary

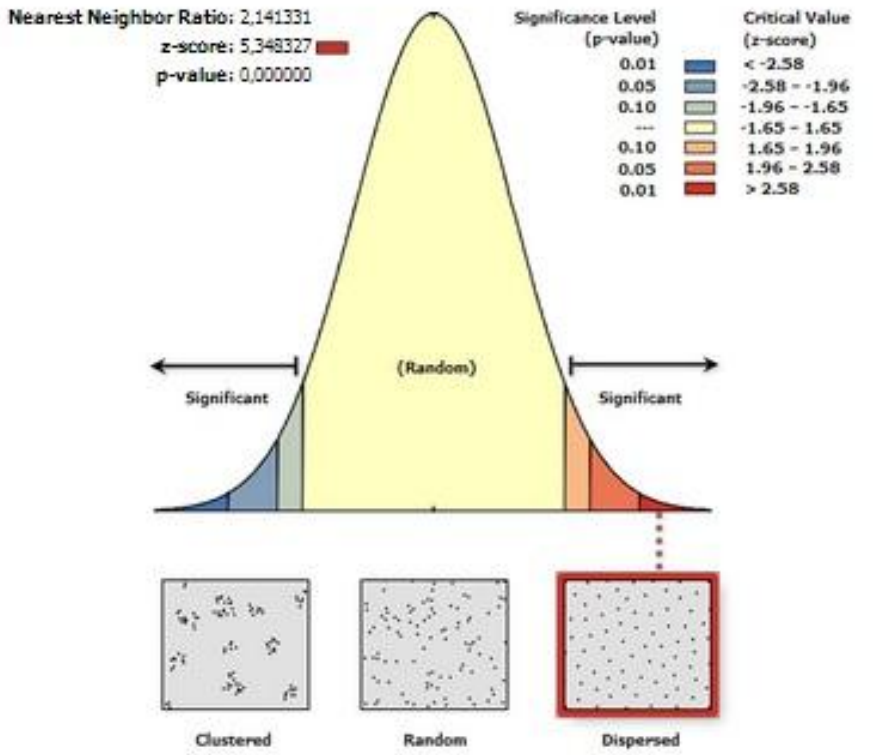
Observed Mean Distance:	0,474560
Expected Mean Distance:	0,430476
Nearest Neighbor Ratio:	1,102409
z-score:	1,328771
p-value:	0,183924

Dataset Information

Input Feature Class:	ERZAK_AMBARI
Distance Method:	EUCLIDEAN
Study Area:	34,096908

Average Nearest Neighbor Summary of Supply Warehouses

Average Nearest Neighbor Summary



Given the z-score of 5,35, there is a less than 1% likelihood that this dispersed pattern could be the result of random chance.

Average Nearest Neighbor Summary

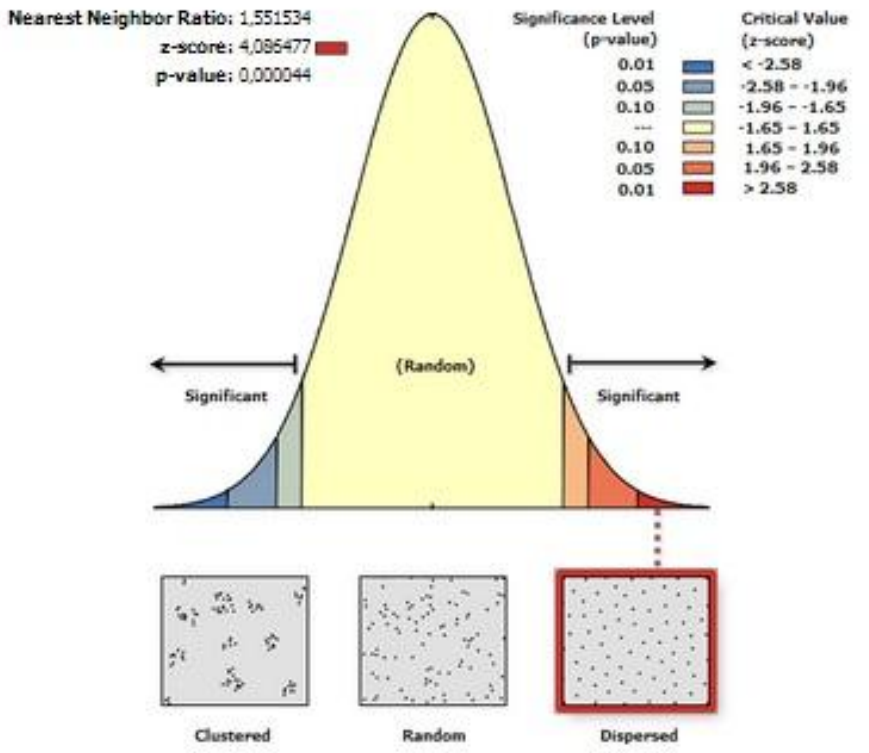
Observed Mean Distance:	1,187753
Expected Mean Distance:	0,554680
Nearest Neighbor Ratio:	2,141331
z-score:	5,348327
p-value:	0,000000

Dataset Information

Input Feature Class:	TECHIZAT_AMBARI
Distance Method:	EUCLIDEAN
Study Area:	7,384073

Average Nearest Neighbor Summary of Ordnance Depots

Average Nearest Neighbor Summary



Given the z-score of 4.09, there is a less than 1% likelihood that this dispersed pattern could be the result of random chance.

Average Nearest Neighbor Summary

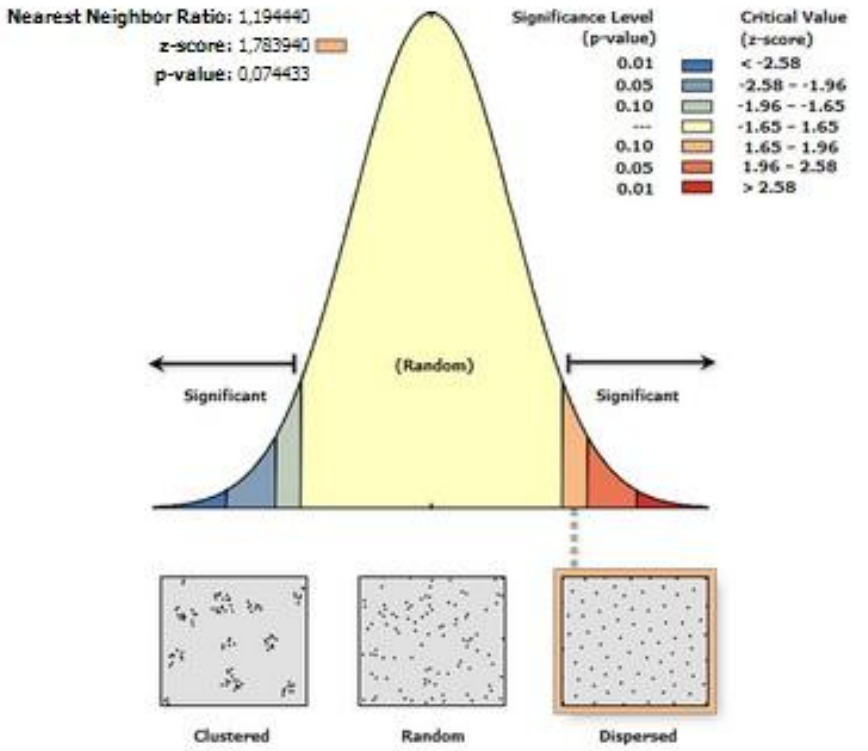
Observed Mean Distance:	0,886231
Expected Mean Distance:	0,571197
Nearest Neighbor Ratio:	1,551534
z-score:	4,086477
p-value:	0,000044

Dataset Information

Input Feature Class:	MUHIMMAT_DEPOSU
Distance Method:	EUCLIDEAN
Study Area:	19,575935

Average Nearest Neighbor Summary of Ammunition Dumps

Average Nearest Neighbor Summary



Given the z-score of 1.78, there is a less than 10% likelihood that this dispersed pattern could be the result of random chance.

Average Nearest Neighbor Summary

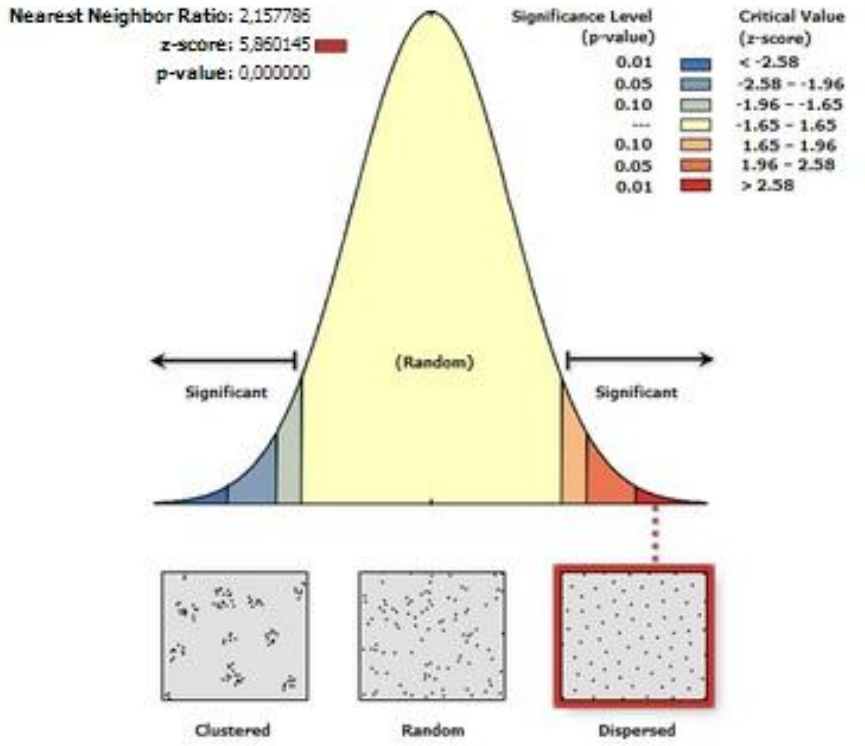
Observed Mean Distance:	0,652916
Expected Mean Distance:	0,546629
Nearest Neighbor Ratio:	1,194440
z-score:	1,783940
p-value:	0,074433

Dataset Information

Input Feature Class:	HASTANELER
Distance Method:	EUCLIDEAN
Study Area:	27,489923

Average Nearest Neighbor Summary of Hospitals

Average Nearest Neighbor Summary



Given the z-score of 5,86, there is a less than 1% likelihood that this dispersed pattern could be the result of random chance.

Average Nearest Neighbor Summary

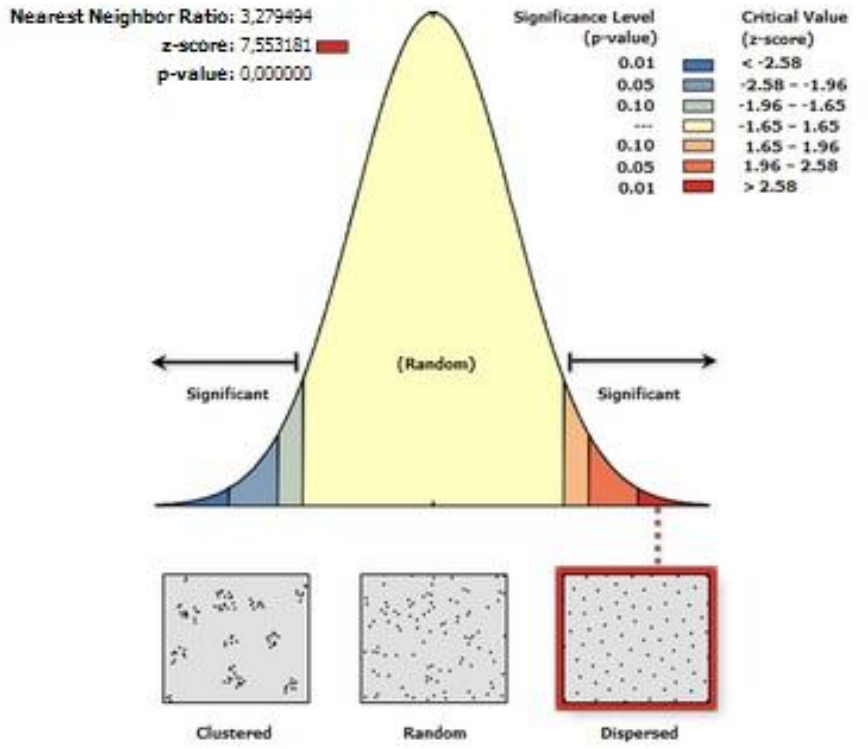
Observed Mean Distance:	1,316335
Expected Mean Distance:	0,610040
Nearest Neighbor Ratio:	2,157786
z-score:	5,860145
p-value:	0,000000

Dataset Information

Input Feature Class:	NEKAHATHANE
Distance Method:	EUCLIDEAN
Study Area:	10,420155

Average Nearest Neighbor Summary of Convalescent Hospitals

Average Nearest Neighbor Summary



Given the z-score of 7.55, there is a less than 1% likelihood that this dispersed pattern could be the result of random chance.

Average Nearest Neighbor Summary

Observed Mean Distance:	3,195340
Expected Mean Distance:	0,974339
Nearest Neighbor Ratio:	3,279494
z-score:	7,553181
p-value:	0,000000

Dataset Information

Input Feature Class:	BENZIN_DEPOSU
Distance Method:	EUCLIDEAN
Study Area:	11,392048

Average Nearest Neighbor Summary of Oil Depots