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M.Sc. in Industrial Engineering

İLHAN KESER

**REPUBLIC OF TURKEY
GAZİANTEP UNIVERSITY
GRADUATE SCHOOL OF NATURAL & APPLIED SCIENCES**

**A GIS BASED AHP SITE SELECTION METHOD FOR A
DISASTER LOGISTICS WAREHOUSE: A GAZİANTEP CASE**

**M.Sc. THESIS
IN
INDUSTRIAL ENGINEERING**

**BY
İLHAN KESER
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**M.Sc. Thesis
in
Industrial Engineering
Gaziantep University**

**Supervisor
Assoc. Prof. Dr. Cihan ÇETİNKAYA**

**by
İlhan KESER
December 2019**



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GAZİANTEP UNIVERSITY
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INDUSTRIAL ENGINEERING

Name of the Thesis: A GIS Based AHP Site Selection Method for A Disaster Logistics
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Name of the Student : İlhan KESER

Exam Date : 13.12.2019

Approval of the Graduate School of Natural and Applied Sciences

Prof. Dr. A. Necmeddin YAZICI
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Prof. Dr. Serap ULUSAM SEÇKİNER
Head of Department

This is to certify that we have read this thesis and that in our consensus/majority opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Assoc. Prof. Dr. Cihan ÇETİNKAYA
Supervisor

Examining Committee Members:

Signature

Assoc. Prof. Dr. Cihan ÇETİNKAYA

.....

Assoc. Prof. Dr. Eren ÖZCEYLAN

.....

Asst. Prof. Dr. İbrahim AKBEN

.....

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İlhan KESER

ABSTRACT

A GIS BASED AHP SITE SELECTION METHOD FOR A DISASTER LOGISTICS WAREHOUSE: A GAZİANTEP CASE

KESER, İlhan

M.Sc. in Industrial Engineering

Supervisor: Assoc. Prof. Dr. Cihan ÇETİNKAYA

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In recent years, the number and severity of both natural and man-made disasters has been increasing. Therefore, disaster logistics, which aims to provide the necessary aid materials (tents, food, water, medicine, etc.) at the right time, at the right place, at the right cost, and quickly to the right people, is becoming increasingly important in large-scale disasters. In this study, selection problem of Disaster logistics warehouse establishment for Gaziantep province has been examined by using the Analytical Hierarchy Process (AHP) which is supported by Geographic Information Systems (GIS). Firstly, site selection criteria were determined for disaster logistics warehouse from the literature and from opinions of experts at AFAD (Disaster and Emergency Management Presidency, under auspicious of Ministry of Interior). The AHP method is used to weigh the specified criteria according to their severity. Then, data layers of the criteria of Gaziantep are analyzed by using the spatial importance on warehouse site selection analysis tools provided by GIS. In the result analysis, the areas where the disaster logistics warehouses can be installed in the study area were determined based on their suitability degree. Consequently, it was found that 1.3% of the study area was quite suitable, 1.16% was moderately suitable, 1% was barely suitable, and 96.54% was not suitable for disaster warehouse sitting. Additionally, the studies in the literature were examined and the weights of the determined criteria were changed so as to examining the method that was used and the result data for the scenario which was obtained on the recalculated weights. It was found that different results were achieved in site selection with the weights determined between the two scenarios. Having examined the literature, it has been seen that the number of studies on GIS supported AHP method in disaster logistics is quite limited and it is expected that the method used in this study will contribute to the decision makers and the literature.

Key Words: Disaster Logistics, MCDM, AHP, GIS, Gaziantep.

ÖZET

CBS TABANLI AHP METODU İLE AFET LOJİSTİK DEPOSU YER SEÇİMİ: GAZİANTEP ÖRNEĞİ

KESER, İlhan

Yüksek Lisans Tezi, Endüstri Mühendisliği

Danışman: Doç. Dr. Cihan ÇETİNKAYA

Aralık 2019

86 sayfa

Son yıllarda doğal ya da insan kaynaklı yaşanan afetlerin sayısı ve şiddeti gittikçe artmaktadır. Bu nedenle büyük ölçekli afetlerde gerekli yardım malzemelerinin (çadır, gıda, su, ilaç, vb.) doğru zamanda, doğru yerde, doğru maliyetle ve doğru kişilere hızlı bir şekilde ulaştırılmasını amaçlayan afet lojistiği giderek daha da önem kazanmaktadır. Bu çalışmada Coğrafi Bilgi Sistemleri (CBS) destekli Analitik Hiyerarşi Yöntemi (AHY) kullanılarak Gaziantep ili için afet lojistiği depo kuruluş yer seçimi problemi ele alınmıştır. Çalışmada öncelikle afet lojistik deposu için literatürden ve AFAD'ta çalışan uzman kişilerin görüşleri doğrultusunda yer seçim kriterleri belirlenmiştir. Belirlenen kriterlerin önem derecelerine göre ağırlıklandırılmasında Analitik Hiyerarşi Yöntemi (AHY) kullanılmıştır. AHY ile ağırlıkları hesaplanan kriterlerin Gaziantep İline ait veri katmanları Coğrafi Bilgi Sistemleri'nin (CBS) sağladığı konumsal analiz araçları yardımıyla analiz edilmiştir. Sonuç analizinde çalışma bölgesinde afet lojistik deposu kurulabilecek alanlar uygunluk derecesine göre belirlenmiştir. Sonuç olarak; çalışma alanının %1.3'ü çok uygun, %1.16'sı orta uygun, %1'i az uygun, %96,54'ün ise afet lojistik deposu kurmak için hiç uygun olmadığı tespit edilmiştir. Ayrıca literatürdeki çalışmalar incelenmiş olup, belirlenen kriterlerin ağırlıkları kullanılan yöntemin irdelenmesi adına değiştirilerek, yeniden hesaplanan ağırlıklar üzerinden senaryo için sonuç verisi elde edilmiştir. İki senaryo arasında belirlenen ağırlıklarla birlikte yer seçiminde farklı sonuçlara ulaşıldığı görülmüştür. Literatür incelendiğinde afet lojistiğinde CBS destekli AHY yöntemini ele alan çalışma sayısının oldukça kısıtlı olduğu görülmüş olup, bu yönüyle çalışmada kullanılan yöntemin karar vericilere ve literatüre katkı sağlayacağı düşünülmektedir.

Anahtar Kelimeler: Afet Lojistiği, Çok Kriterli Karar Verme Tekniği, AHY, CBS, Gaziantep.



“Dedicated to my family”

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LIST OF SYMBOLS

Km	Kilometer
Km²	Square kilometer
M²	Square meters
%	Percent



LIST OF ABBREVIATIONS

AFAD	Directorate of Disaster and Emergency Management
AHP	Analytical Hierarchy Process
ANP	Analytical Network Process
AYDES	Disaster Management Decision Support Systems
DSS	Decision Support System
ELECTRE	Elimination and Choice Translating Reality English
ESRI	Environmental Systems Research Institute
FAHP	Fuzzy Analytic Hierarchy Process
GDEM	Global Digital Elevation Model
GIS	Geographic Information System
KBRN	Chemical, Biological, Radioactive, Nuclear
MAUT	Multi-Attribute Utility Theory
MCDM	Multi-Criteria Decision Making
NGO	Non-Governmental Organization
OWA	Ordered Weighted Averaging
RI	Random Index
SAW	Simple Additive Weighting
TAMP	Turkey Disaster Response Plan
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
UTADIS	Utilites Additives Discriminants
WLC	Weighted Linear Combination

CHAPTER 1

INTRODUCTION

In recent years, the negative consequences caused by disasters are gradually increasing in terms of economic, social, cultural and psychological both in Turkey and in the world. This requires the effective, planned and coordinated implementation of the processes in disaster management activities. In this aspect, logistic processes have gained importance in disaster management. Disaster management logistics processes consist of pre-disaster preparation, immediate response, and improvement stages (Börühan et al., 2012).

The basic needs for disaster victims in disaster managements are mainly medical equipment, food material, tents, containers, beds, etc. It inevitably requires to deliver products on time, in the correct place, under the necessary conditions, at the proper cost, to the people in need.

Disaster logistics warehouses have been established so far for rapid and coordinated delivery of aid to disaster areas in 25 provinces of Turkey which are Adana, Adıyaman, Afyon, Aksaray, Ankara, Antalya, Bursa, Denizli, Diyarbakır, Düzce, Elazığ, Erzincan, Erzurum, Manisa, Kahramanmaraş, Kastamonu, Kırıkkale, Kocaeli, Muğla, Muş, Samsun, Sivas, Tekirdağ, Van, and Yalova.

In this system where all the possibilities of technology are used, it is aimed to reach disaster areas as soon as possible. Furthermore, the damage to the economy will be reduced as a result of effective and efficient use of the country's resources.

Due to the high earthquake risk of Gaziantep's Nurdagi and Islahiye districts and the internal turmoil erupted in Syria in 2011, there is the possibility of establishing a disaster logistics warehouse by AFAD that will be able to deliver humanitarian aid from Turkey to the affected people in Syria quickly and at lower cost. For this reason,

the Gaziantep province was chosen as the study area. The aim of the study is to develop a location selection method that uses the Analytical Hierarchy Method (AHP) with the Geographic Information System (GIS) support for the disaster logistics storage area in Gaziantep province.

The thesis consists of six chapters. The introduction which aims to explain structure of the study and knowledge about disaster logistics, is presented in the first chapter. In the second chapter, the literature review on the use of GIS and Multi Criteria Decision Making Technique together with disaster management, and the site selection studies that uses GIS-supported AHP are presented. In the third chapter, details about GIS software and AHP application, which are the material and methods to be used in the study, are explained.

When it comes to the fourth chapter, the criteria determined in the study are explained in detail and the weight values of the criteria are calculated with the AHP technique on Expert Choice program. Subsequently, site suitability analysis for disaster logistics warehouse area are performed with ArcGIS program. In the fifth chapter, the results of the analysis are evaluated on the relevance maps and obtained findings. In the last part of the study, results and recommendations are shared based on the findings obtained at the end of the study.

1.1 Aim and Motivation of the Study

The main aim of this study is to determine the most suitable areas for disaster logistics warehouse in Gaziantep province by using Geographic Information Systems (GIS) and Analytical Hierarchy Process (AHP). Additionally, to demonstrate the use of AHP method and GIS software together as an effective tool in disaster logistic warehouse site selection. On the other hand, another aim of the study is contributing to the rapid delivery of materials in case of need in the possible post-disasters in the Gaziantep province. Likewise, the last aim of the study is to explore how to reduce the prospective damage to the economy through using the country's resources effectively and efficiently.

1.2 Basic Disaster Terms

Disaster: According to AFAD, those people who have a physical, economical, social and environmental losses, interrupted regular life and human activities, affected communities that can't deal using local and natural sources, technological or human origin events. Disaster is not the case itself, it is the result of which it occurs (AFAD, 2019a).

Emergency: In the definition of AFAD, it has been described as the events that have stopped or disrupted the normal life and activities of all or certain segments of the society and that require urgent intervention and the crisis created by these events (AFAD, 2019a).

Danger: Life-threatening, physical events and cases that have the potential to harm the environment. In other words, danger is described as all cases that may cause physical, economic and social destruction in terms of natural, technology or humanities (AFAD, 2019a).

Risk: A concept that expresses the measure of the values to be lost in a particular area, or the sum of the negative consequences of an event, depending on the likelihood of danger (Kadioğlu & Özdamar, 2007).

Disaster Risk: The probability of losses that a particular hazard may create in proportion to human settlements and the natural environment, or damage in the future, if a certain danger occurs within a certain period of time (Kadioğlu & Özdamar, 2007). Different impacts of different disasters are occurring on the basis of world, country, region, province, district and even sub-regions. Classification of disasters seen in the world can be examined on Table 1.1.

Table 1.1 Types of disasters observed in the world (AFAD, 2019b)

GEOLOGICAL DISASTERS	CLIMATIC DISASTERS	BIOLOGICAL DISASTERS	SOCIAL DISASTERS	TECHNOLOGICAL DISASTERS
- Earthquake	- Hot wave	- Erosion	- Fires	-Mining
- Landslide	- Cold wave	-Outbreaks	- Wars	accidents
- Rock Fall	- Drought		-Terrorist	- KBRN
-Volcanic	- Full Hose		attacks	accidents
Eruptions	- Lightning		-Migrations	-Industrial
- Mud	- Hurricane			accidents
Currents	- Torrent			
- Tsunami	- Avalanche			
	-Air pollution			

1.3 Disaster Management System in Turkey

Turkey is often faced with natural disasters due to its land structure, ground shapes and the negativity of meteorological conditions. The effects of natural disasters are economically, politically, socially damaging to the society. Rapid population growth and irregular developments in settlement places increase the damage of natural disasters.

With the Law No. 5902 enacted in 2009, the Disaster and Emergency Management Presidency under auspicious of the Ministry of Interior was established in Turkey and the authorities, responsibilities and coordination in disaster and emergency situations were gathered under a single roof (AFAD, 2009c).

In this context, in our country, a new disaster management model has been put into practice and with this model, and the priority has been given to **“Risk Management”** from **“Crisis Management”**. The model, called **“Integrated Disaster Management System”** is given in Figure 1.1 that will prevent or minimise the hazards and risks that may occur before the disaster to prevent damages caused by disasters and emergencies.

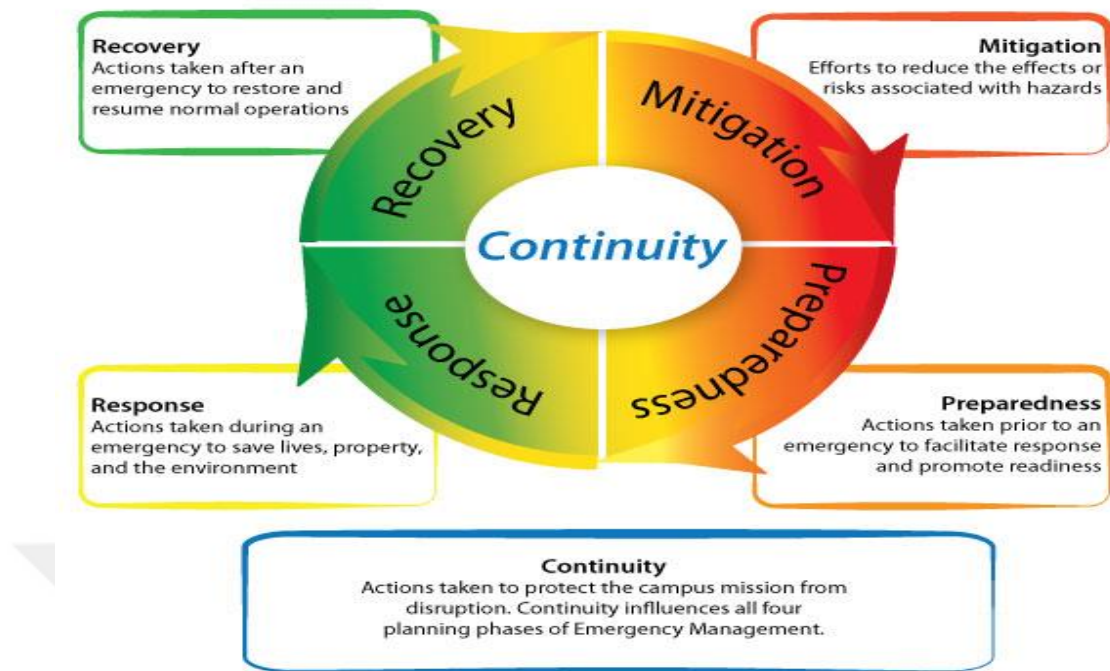


Figure 1.1 Disaster Management Process (Burke, 2013)

Turkish Disaster Response Plan, prepared by AFAD in 2013, is the most comprehensive plan ever made in. It has an important place as an action plan for different events and situations, including the worst possible scenarios. Turkey Disaster Response Plan established in an integrated manner with the Disaster Management Decision Support Systems (AYDES) the disaster is carried out more effectively and faster through it's software which contains personnel, tools, equipment, maps, etc., by transferring all information to the digital environment.

1.4 Disaster Logistics and AFAD Lojistics Warehouses

1.4.1 Disaster Logistics

Disaster logistics cover many different activities at different times, to respond quickly to various disasters. Although such activities vary depending on the type of disasters that occur, the common goal is to "Save the human life". Disaster logistics is defined as "Efficient and cost effective flow and storage, planning and implementation and control of goods, and related information from the first production point to the last consumption point in order to meet the needs of the injured people" (Börühan et al., 2012).

Disaster logistics is, planning, implementation and management of storage and flow of aid materials and necessary information. Efficiency and cost are also need to be considered in this process. Preparedness, procurement, transportation, tracing, storing, inventory management and customs clearance are among disaster functions (Köseoğlu & Yıldırım, 2015a). Humanitarian logistics is a branch of logistics which specializes in organizing the delivery and warehousing of supplies during natural disasters or complex emergencies to the affected area and people. Figure 1.2 shows the humanitarian logistics supply chain.

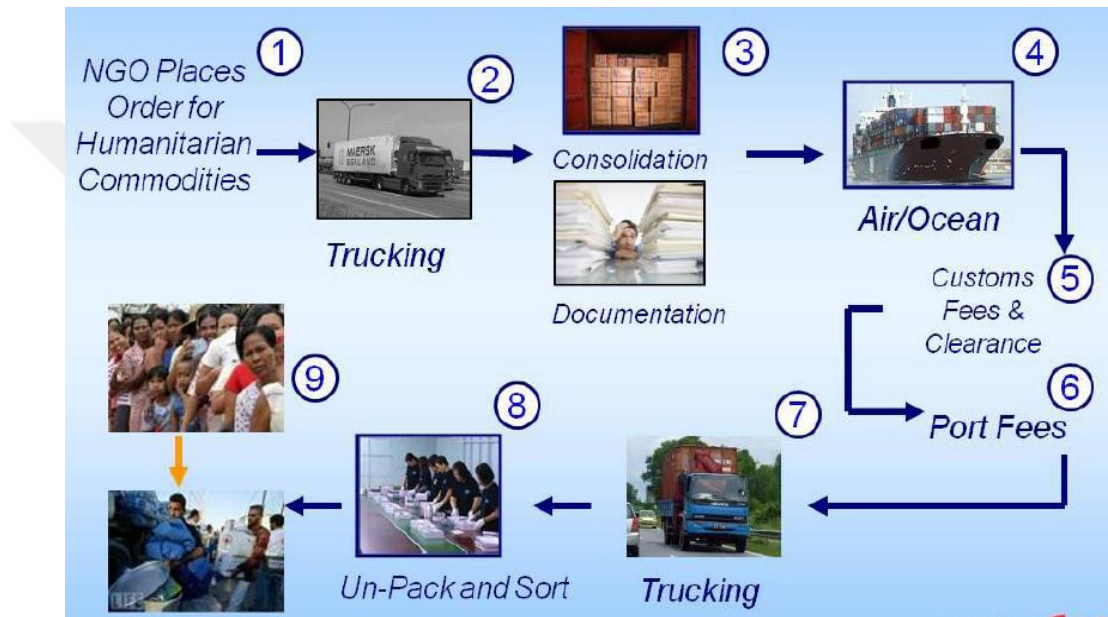


Figure 1.2 Humanitarian Logistics Supply Chain (Cuzzolino, 2012)

Humanitarian operations are national and international, but require the cooperation of many institutions, organisations, individuals and governments. It is possible to send humanitarian aid materials to needy areas quickly and accurately through logistic activities that are well planned. The most important and cost-effective part of disaster management consists of logistical activities. Therefore, the good planning and proper implementation of activities is of great importance for the success of the aid operations. The detailed planning of activities is done in preparation, providing great conveniences to meet the needs in the event of disaster. Logistics planning must be covered by many scenarios, and it should include alternatives and should be in full compliance with disaster management planning (Köseoğlu & Yıldırım, 2015b).

1.4.2 AFAD Logistics Warehouses

While the number and severity of poverty and climate change are increasing, technological and human disasters also lead to more people being sheltered year after year. In this context, disaster logistics warehouses have been established by AFAD to cover the necessities of disaster victims by searching, rescue, health, housing etc., and to store tents and emergency response materials to supply the essential needs of the personnel from public institutions and organizations going to the disaster area.

AFAD has defined 15 zones for disaster logistics planning and cooperation under the Turkish Disaster Response Plan (TAMP) and 4 intervention levels have been defined so far (AFAD, 2013). As of today, AFAD has 25 disaster warehouses that can serve in 15 regions (Figure 1.3, AYDES program can only be used by AFAD authorized people).

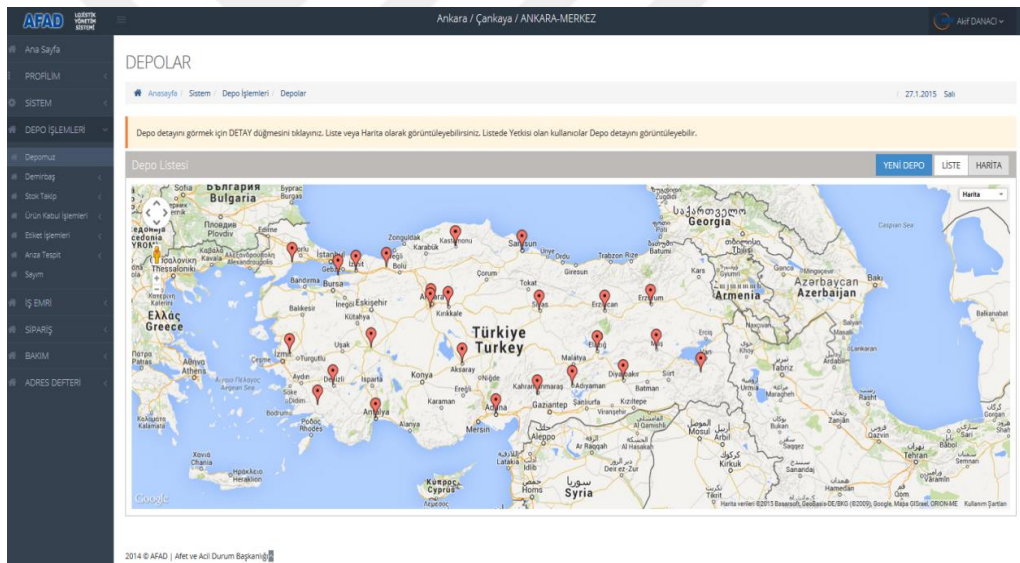


Figure 1.3 AFAD logistics warehouses in 25 cities (AYDES, 2019)

The locations where the warehouses will be established are determined by the frequency of exposure to disaster, types of disaster, the average annual damage rate, transportation and population characteristics. The present AFAD warehouses are built on an area of 10,000 m² and have a covered area of 2,400 m². Figure 1.4 shows the architecture of AFAD logistics warehouses.



Figure 1.4 Architectural model of AFAD logistics warehouses

Figure 1.5 shows an established AFAD logistics warehouse.



Figure 1.5 AFAD logistics warehouse

There are 120 thousand tents and tent material (kitchen set, bed, blanket, heater, lighting, etc.) in the temporary shelters in 25 disaster logistics warehouses. AFAD has implemented a concept for the protection of aid supply materials in these warehouses, transportation to the disaster areas in accordance with standards suitable for trans-ocean transportation and monitoring of all these processes. The architectural structure of the warehouses has been designed with reference to the criteria for rapid, efficient and effective intervention within the scope of the concept prepared with the academicians interested in logistics. In this context, in the construction of warehouses, modular warehouses can easily be expanded by using modular steel construction at any time.

CHAPTER 2

LITERATURE REVIEW

In this part of the study, the previous studies that use GIS and MCDM methods in disaster management for site selection studies are shown in Table 2.1.

Table 2.1 Studies of GIS-based MCDA on disaster management

Author (s)	Approach	Problem Area
Chen and Blong (2001)	GIS-TOPSIS	Towards an Integrated Approach to Natural Hazards Risk Assessment Using GIS: With Reference to Bushfires
Rashed and Weeks (2003)	GIS-OWA	Assessing Vulnerability to Earthquake Risk for Los Angeles
Levy (2005)	GIS-ANP	Decision Support Systems for Flood Risk Management for Yangtze River
Kavzoğlu et al. (2010)	GIS- AHP- WLC	GIS-based Landslide Susceptibility Mapping Using Multicriteria Decision Analysis Method: The Case of Trabzon Province
Yavuz (2013)	GIS- AHP	Implementation of GIS-based Multi Criteria Decision Making Methods in the Context of Earthquake Sensitive Planning: Yalova City Center Case
Selçuk (2013)	GIS-AHP	An Avalanche Risk Model for Bitlis Province, Turkey
Akıncı et al. (2015)	GIS-AHP	Landslide Susceptibility Assessment in Planned Areas Using Geographical Information Systems and AHP Method: The Case of Artvin
Çetinkaya et al. (2016)	GIS-FAHP- TOPSIS	GIS-Based Fuzzy MCDA Approach For Siting Refugee Camp: A Case Study For Southeastern Turkey
Nyimbili et al. (2018)	GIS-AHP- TOPSIS	Integration of GIS, AHP and TOPSIS for Earthquake Hazard Analysis
Nazmfar et al. (2019)	GIS- Fuzzy ANP	Vulnerability evaluation of urban buildings to various earthquake intensities: A case study of the municipal zone 9 of Tehran
Souissi et al. (2019)	GIS-AHP	GIS-based MCDM - AHP modeling for flood susceptibility mapping of arid areas, southeastern Tunisia

GIS is used in site selection, including agriculture, city planning, supply chain management and complex construction projects (ESRI, 2019a). In the literature review, there are plenty of studies used together with GIS and MCDA techniques in disaster management. In addition, GIS and MCDA techniques are used together in many areas for site selection (school, housing, solid waste storage, etc.). For instance, Chen and Blong (2001), have developed a GIS-based integrated approach for risk assessment in natural hazards, with reference to bushfires. The paper concludes that their approach can be used to assist risk management of natural hazards, both in theory and in practice. On the other hand, regarding assessing urban vulnerability through a spatial analytical procedure, Rashed and Weeks (2003), provide findings from a project in which a GIS methodology regarding OWA has been developed. The results suggest that the proposed methodology may provide a new approach for analysing vulnerability that can contribute on current understanding of human/hazards interaction.

Furthermore, the research of Levy (2005), which uses ANP with GIS, has shown that DSS and MCDM can improve flood risk planning and management under uncertainty by providing data displays, analytical results, and model output to summarize critical flood information.

There are also various studies about Middle East and Central Asia as well. For instance, the work of Vahidnia et al. (2009), intends to determine the most suitable area for a new hospital location in Iranian capital Tehran, with the FAHP supported by GIS was used to calculate and classify management criteria, and FAHP was used to evaluate decision factors and their impact on alternative regions. The utility of the new hospital site is evaluated by calculating an accessibility index for each pixel in the GIS, defining it as the ratio of population density to travel time. With the addition of a new hospital to the optimum site, this index has shown that they will show an improvement over 6.5% of the geographical area.

Kavzoğlu et al. (2010), aims to create a landslide susceptibility risk map for Trabzon. In order to produce the landslide susceptibility map, Analytical Hierarchy Method and Weighted Linear Combination Method which is one of the multi criteria decision analysis techniques were used together. The produced map for landslide susceptibility

was compared with the existing landslide areas and it was determined that the total high and very high risk areas overlap approximately 78%. The findings of the study showed that GIS based multi-criteria decision analysis method can be used as an effective method in the production of risk maps.

Another scientist who contributes on the field by using GIS is Yavuz (2013). GIS was used in the works of Yavuz within the scope of earthquake sensitive planning in Yalova city center to determine the risks arising from urban and soil characteristics. For this purpose, urban criteria and soil criteria were first subjected to the Analytical Hierarchy Process (AHP). The urban risk and soil risk maps, which show the risky areas obtained as a result of the AHP, were included as input for the TOPSIS analysis. As a result of the TOPSIS analysis, a general risk map containing both urban and ground criteria was obtained.

In the year of 2013, a study based on GIS, was conducted by Selçuk (2013) to determine the avalanche danger area of the province through the AHP and evaluate it with sensitivity and accuracy analysis by using Multi-Criteria Decision Analysis (MCDA). The settlements cover an area of approximately 39,741 hectares and only 41 settlements (villages and towns) have ideal topographic features to prevent avalanche danger, but 82% are unsuitable. The avalanche hazard model shows that the southeast and southwestern parts of Bitlis (Center), Tatvan and Hizan districts have the highest avalanche hazard risk.

The work of Akıncı et al. (2015), has produced a landslide susceptibility map based on the area within the boundary of Artvin's Central Municipality for revision of the zoning plan by using GIS supported Analytic Hierarchy Process (AHP) method. Lithology, altitude, slope, view and proximity to the river were used in the landslide susceptibility analysis, and achieved valuable results. For example, according to the evaluations, 15% of the study area is very high, 25.52% is high, 28.95% is medium, 18.77% is low and 11.76% is very low sensitive to landslides.

Likewise, Çetinkaya et al. (2016), has developed a three-step solution approach for Firstly, various geographic, social, infrastructural and risk related criteria are determined for 10 southeastern cities, particularly Gaziantep, in Turkey which are very close to Syrian border. Secondly, these criteria are entered into GIS software to assign

a refugee camp siting availability score. Lastly, indicators are prioritized using Fuzzy Analytic Hierarchy Process (FAHP) and potential refugee camp sites are ranked by using Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). As a result, 15 new refugee camp sites are offered considering the pre-determined indicators. The model definitely shows that suggested alternative camp locations are more suitable than the current camps.

Furthermore, Nyimbili et al. (2018), has integrated AHP and the TOPSIS with the GIS, so as to produce earthquake hazard and risk maps for earthquake disaster monitoring and analysis for a case study region of Küçükçekmece in Istanbul, Turkey. The resulting earthquake hazard maps created by both the AHP and TOPSIS models were compared, showing high correlation and compatibility. To estimate the elements at risk, population and building data were used with the AHP and TOPSIS hazard maps for potential loss assessment. Therefore, it demonstrated the potential of integrating GIS with AHP and TOPSIS in generating hazard maps for effective earthquake disaster and risk management.

The study of Nazmfar et al. (2019), also aims to evaluate the vulnerability of urban buildings in zone 9 of Tehran to various earthquake intensities. For this purpose, under weighting and fuzzification against earthquake, adopting Analytical Network Process (ANP) - Fuzzy planning models, 10 effective factors on vulnerability of the aforesaid zone were employed. The selected layers in GIS environment were composed, and eventually, the generalized vulnerability mapping for the zone was prepared. On the end, the vulnerability degrees of the buildings were divided to five categories which are very low, low, average, high, and very high based on the obtained results. Therefore, the information provided by these maps could help citizens, planners and engineers to reduce losses caused by present and future earthquake by means of mitigation, prevention, and avoidance. Additionally, the present study of Souissi et al. (2019), is an attempt to prepare a flood hazard susceptibility map of the Gabes region using 'multi-criteria decision making – analytical hierarchy process' model in the GIS environment. Eight factors were used in flood modelling. The impact of each element that contributes to the flood risk was examined by weights using the AHP method. The obtained results have shown that the flood hazard index is equal to 6.30, and the most significant flood occurrence factor is the elevation (22.5%), approximately 15% of the

total area is flooded. The validation of results by a susceptibility zones histogram has shown that 74.51% of the observed flood areas are mostly concentrated in a moderate to very high susceptibility zone.

In the literature review, the studies used together with GIS and MCDA methods in disaster management are examined in Table 2.1. **Apart from these studies, some studies related to the site selection problem that uses GIS and AHP method are also examined.** In one of these studies, Uyan (2013), examined the solar power plants' site selection problem for decision makers. The aim of this study was to determine the most suitable site for solar power plant by using Geographical Information System (GIS) and Analytic Hierarchy Process (AHP) in Konya's Cumra district. According to the results, 1.5% of the study area has high suitability, 26% has moderate suitability, and 11% has low suitability for the solar power plant sites. **This paper is similar to our proposed study in terms of creating a suitability map.**

Guler (2017), investigated the alternative storage location selection problem for the Istanbul province of Turkey by using Geographical Information Systems (GIS) and Analytical Hierarchy Process (AHP). 11 factors were used in the study, two of which belong to two main categories: environmental and economic. Environmental factors; Land use, geology, settlement areas, surface waters, population density, airports and protected areas. Economic factors are a slope, solid waste transfer stations, land values, and roads. Alternative solution proposals have been produced by analysing the criteria of the AHP and the weighted data of the Istanbul province with the help of the spatial analysis tools provided by GIS.

Additionally, there is a similar study which only used Multicriteria Decision Making Method on disaster logistics warehouse location selection within the scope of disaster logistics. In this study, Ofluoglu et al, (2017), used entropy and TOPSIS methods to determine the warehouse location in humanitarian logistics in Trabzon. Firstly, Entropy is used to determine the weights of the criteria. Then, TOPSIS is utilized to rank the warehouse location alternatives. Additionally, the robustness of the approach is examined according to the results of the sensitivity analysis.

Apart from the literature; AFAD site selection of logistics warehouse were founded by AFAD in 25 cities in Turkey (Section 1.5.2) by using the Simple Additive Weighting (SAW), which is one of the Multicriteria Decision Making Method. AFAD (2015) through using the Simple Additive Weighting (SAW) method, has so far established 25 provincial disaster logistics warehouse in Turkey. In the selection of the location of the warehouses, four criteria were determined: Disaster affected population size, closest fault length, logistic sector development index, and accessibility of provinces (highway, seaway, airway). The criteria are given in the values within the determined intervals according to the characteristics of the criteria. Subsequently, it is planned to establish disaster logistics warehouse in the top 25 cities with the highest scoring through the Simple Additive Weighting (SAW) method.

In our study, GIS method and AHP in Gaziantep technique will be used together for site selection of disaster logistics warehouse area. The findings of this study regarding optimum areas are expected to provide guidance for decision makers for a prospective disaster logistics warehouse location to be established by AFAD in Gaziantep province of Turkey. Even though, the criteria that are used for the site selection in the disaster logistics warehouse area vary depending on the working area and preferred severity, the method that is used in this study will contribute to decision makers for selection of the location of prospective disaster logistics warehouse to be established by AFAD. In addition, it is expected that this study will provide guidance for the selection of the location of the disaster logistics warehouses that can be made by the Red Crescent and other NGO's operating in humanitarian aid in disasters. Therefore, it is predicted that this study will contribute on the literature and have a practical dimension.

CHAPTER 3

METHODOLOGY

3.1 Multi-Criteria Decision Making Methods

In recent years, the MCDM methods have attracted the attention of decision makers in the planning and solving of complex projects that host many criteria. By using these methods, decision makers take into account many criteria and produce alternatives to find the best solution. Spatial MCDM methods are an area developed based on the basis of GIS and MCDM. In recent years these systems are implemented in a wide range of areas associated with the space (Uyan, 2013).

Some of the MCDM methods are given below;

- AHP,
- ANP,
- FAHP
- VIKOR,
- TOPSIS
- ELECTRE,
- PROMETHEE,
- OWA,
- SAW,

The MCDM methods used in the problem solutions contain 6 components in general as in the literature as following (Güler, 2017);

- The purpose or objectives group that the decision-making is trying to reach,
- Decision-making or decision-makers of the group to take place with their preferences for benchmark evaluation,
- Determination of the values of the criteria according to the alternative options of the events according to decision makers,

- Determination of alternative decisions,
- Determination of uncontrollable values,
- Determination of alternative feature pairs of the resulting results,

In this study, spatial multi-criterion decision making analysis is conducted, and the AHP technique and the GIS are used together.

3.2 Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process (AHP), developed by Saaty (1980) in the 1980s, is a multi-criteria decision showing the relationship between objective-criterion-sub-criterion and alternatives in a hierarchical structure known as the problem of giving. The reason why that method was preferred in this study is well known and used frequently in the prioritization of decision problems including qualitative and quantitative criteria and advantages of simplicity. The application stages of AHP method are as follows (Keçek & Yüksel, 2016).

Step 1: Creating a Hierarchical Structure

The goal is at the top of the hierarchy in AHP. Therefore, the first thing to be done is to determine the purpose correctly. Once the objective is determined, there are factors and sub-factors that affect the purpose at a lower level. Alternatives are at the bottom of the hierarchy. It is very important that the hierarchy is formed correctly since it has a decisive feature. The hierarchy structure of the AHP can be examined in Figure 3.1.

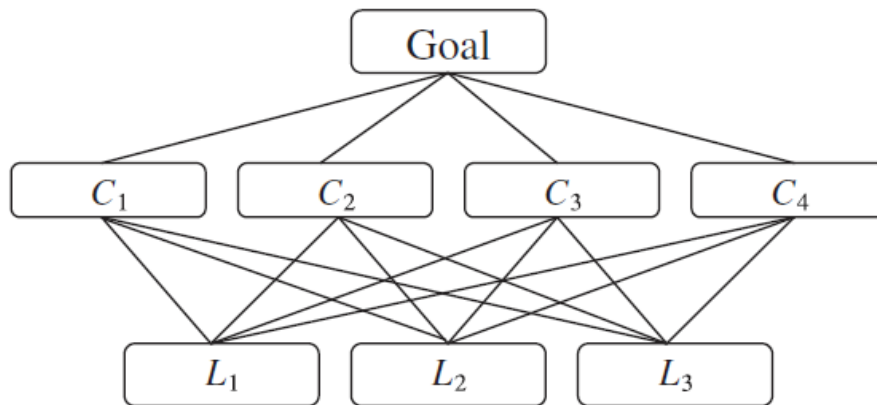


Figure 3.1 Hierarchy model consisting of objectives and criteria and alternatives

Step 2: Creating a Pairwise Comparison Matrix

The a_{ij} element of the square matrix (The decision maker, i . feature with j .) shows the answer to the question of how important the feature is when compared to the criterion at a higher point to which the feature depends. A pairwise comparison matrix is given in Figure 3.2.

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \quad (3.1)$$

where, for all $a_{ij} = 1/a_{ji}$, and for all $i, j = 1, 2, \dots, n$ (Harker & Vargas, 1987)

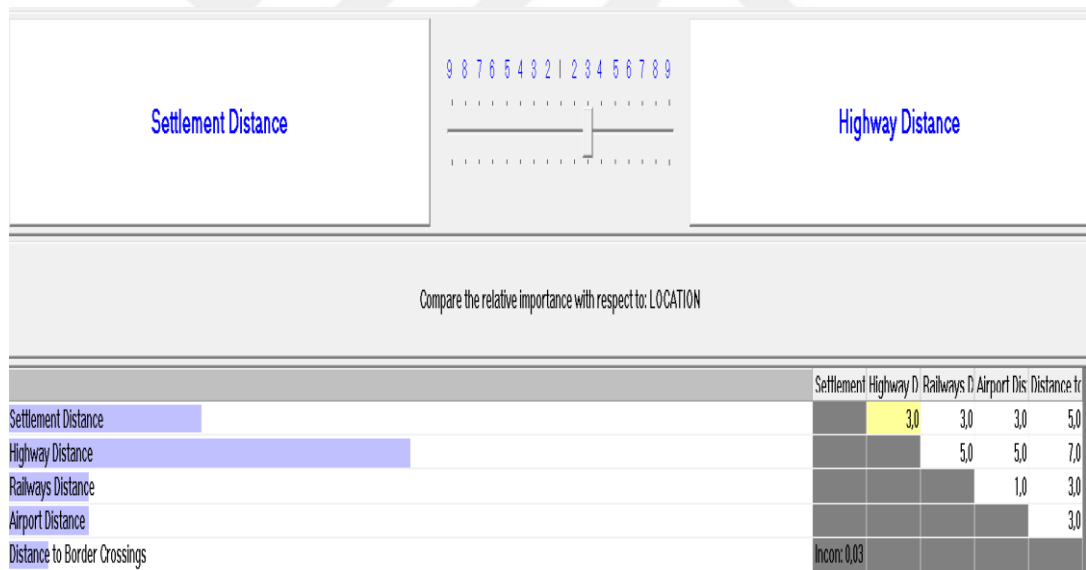


Figure 3.2 Example of pairwise comparison matrix

Pairwise comparisons depend on the decisions of the decision maker. The decision maker makes use of the relative significance scale in Table 3.1 when making a pair comparison.

Table 3.1 Table of importance scale used in pairwise comparison (Saaty, 1980)

Intensity	Definition	Explanation
1	Equal importance	Two barriers contribute equally to the goal
3	Moderate importance	Experience and judgement slightly favours the one over the other
5	Essential or strong importance	Experience and judgement strongly favours the one over the other
7	Demonstrated importance	Dominance of the demonstrated in practice
9	Extreme importance	Evidence favouring the one over the other of highest possible order of affirmation
2,4,6,8	Intermediate values	When compromise is needed

Scores 1, 3, 5, 7, 9 are considered as the main evaluation levels, and scores 2, 4, 6, 8 can be also used in order to express the comparison more precisely.

Step 3: Determination of Eigenvector (Relative Importance Vector)

At this stage, the largest eigenvalue and eigenvector corresponding to this eigenvalue are calculated and normalized in order to obtain the relative priorities of each criterion compared. Although there are different methods in the literature, the most commonly used normalization method; each element of the column is divided by the total value of that column.

Step 4: Calculation of Consistency of Eigenvector

Consistency is determined by calculating inconsistency ratios contained in the pairwise comparison matrix. The discrepancy rate of the pairwise comparison matrix is calculated according to the consistency index and the values of the random index. For this, the consistency index is calculated by having the value of the pairwise comparison matrix ($X_{\max}$) first.

$$\lambda = \frac{\sum_{i=1}^n E_i}{n} \quad (3.2)$$

The comparison matrix is derived from the comparison of its components as a pairwise, and consistency is not guaranteed. In AHP, the comparison matrix consistency is measured by the following consistency index.

$$CI = \frac{\lambda - n}{n - 1} \quad (3.3)$$

In addition, the value of the random index (RI) must be known to evaluate consistency. The corresponding random index value for each matrix size n is given in Table 3.2.

Table 3.2 Random Inconsistency Index (RI)

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R.I.	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

$$CR = \frac{CI}{RI} \quad (3.4)$$

A value less than 0.10 of the calculated CR indicates that comparisons are consistent. If the value of CR is greater than 0.10; can be interpreted as pairwise comparisons are inconsistent or there is a calculation error. In this case, the comparisons should be reviewed again.

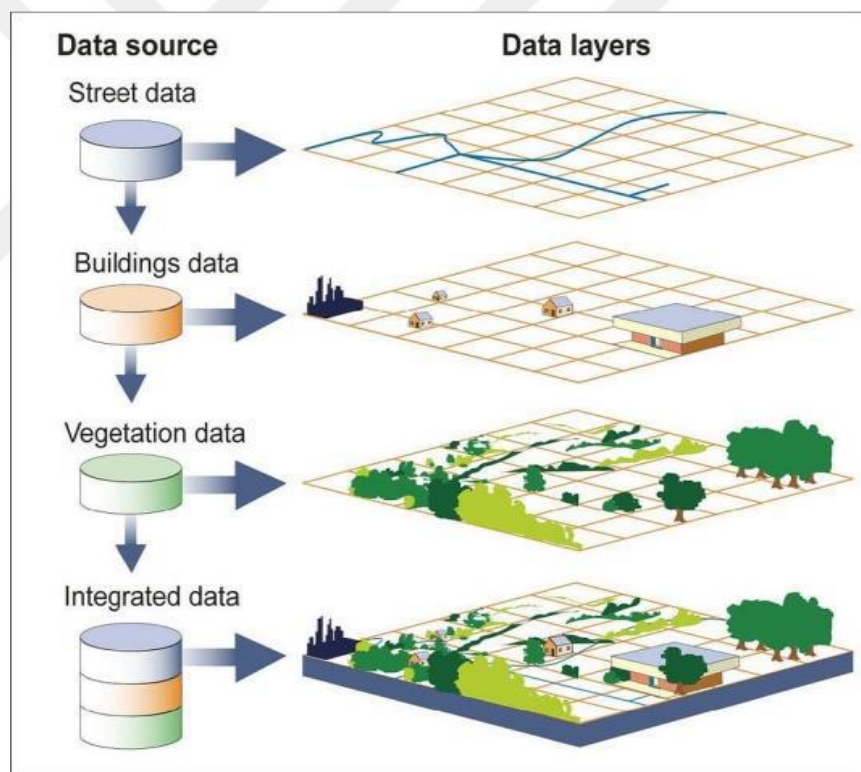
AHP method is used to find the most suitable solution for various problems such as defense industry, engineering, database selection, finance, product design, resource allocation (budget, energy, health), political strategy, transportation, education, site selection, technology transfer (Keçek & Yüksel, 2016). The AHP method has been chosen because the disaster warehouse is simple and very useful for optimum location selection.

3.3 Geographic Information Systems (GIS)

For years, people have tried to interpret, understand and explore the world using models such as maps and spheres. So in 30-40 years, these models have been moved to computers and at the same time the functionality of the models has been increased

by making them more understandable and clearer each year. These models, whose functionality has been increased by means of computers, have been moved to analytical dimensions with Geographical Information Systems (GIS) (Aitzhanov, 2016).

GIS is an information system that integrates functions such as data collection, storage, analysis, and presentation to the user. GIS, which is rooted in Geography, consists of a combination of many data types. GIS provides the visualization of maps and 3D scenes by organizing layers of information together with the analysis of spatial locations entering all areas of our lives. With this unique capability, GIS provides the user with a deeper insight by making cross-data modeling and relationship to help users make smarter decisions (ESRI, 2019b). Figure 3.3 shows a simple example of the data set structure in GIS.



Source: GAO.

Figure 3.3 Simple example of dataset structure (Aitzhanov, 2016)

GIS technology can be used in scientific research, resource management, asset management, infrastructure (natural gas, electricity and water), archeology, environmental impact assessment, urban planning, criminology, geographic history, appropriate location selection, earthquake damage analysis, mine mapping,

cartography, identification of cultivated areas and land crops, meteorology, monitoring military applications, air, maritime and land traffic. On the other hand, GIS is used as an effective and powerful analysis tool in disaster management. GIS is used in disaster management in areas such as disaster forecasting, vulnerability analysis, damage assessment, hazardous materials, infrastructure and mass care/shelter status (Başarsoft, 2019).

The present study has procedures that need to be addressed by GIS to achieve better results. ArcGIS technology is a scalable integrated Geographic Information System software developed by ESRI. All data files must be processed using different modules of the ArcGIS software. Figure 3.4 shows the general analysis steps to be applied in the GIS for the current research.

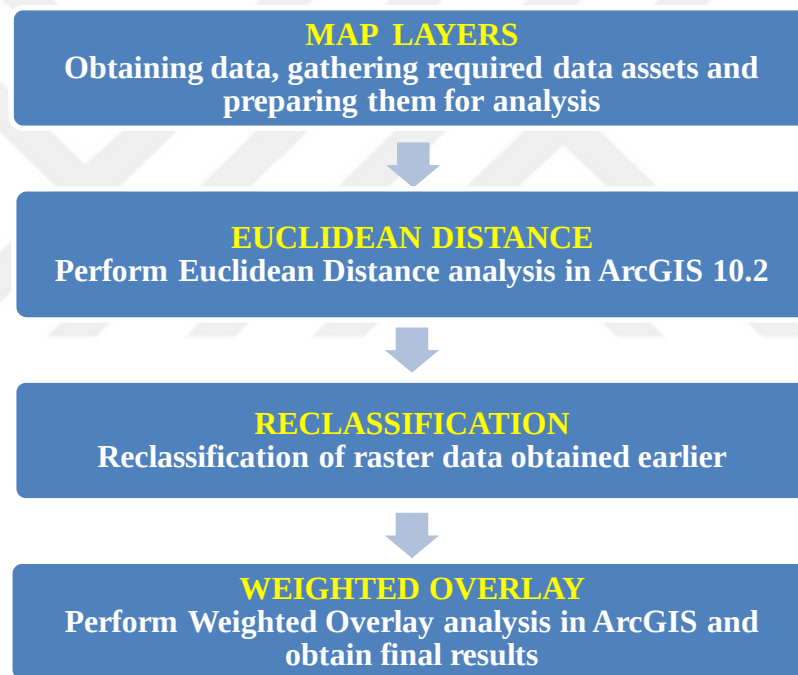


Figure 3.4 The general steps during analysis of map layers using ArcGIS (Aitzhanov, 2016)

The types of analysis used in ArcGIS software are examined under the following titles.

3.3.1 Feature to Raster

Raster data is the expression of spatial data as cellular squares. Represents an actual state in cells (raster cells) with equal rows and columns. Each cell takes different color values depending on the geographic area and defines the geographic area it represents. The size of the raster cells refers to the resolution of the data set and the detail of the

specified area. Satellite photos, scanned plans, orthophotos and all kinds of images work in raster format. The raster layer is added as a separate layer in the layer manager (Töreya et al., 2010). Examples of layers in ArcGIS is given Figure 3.5.

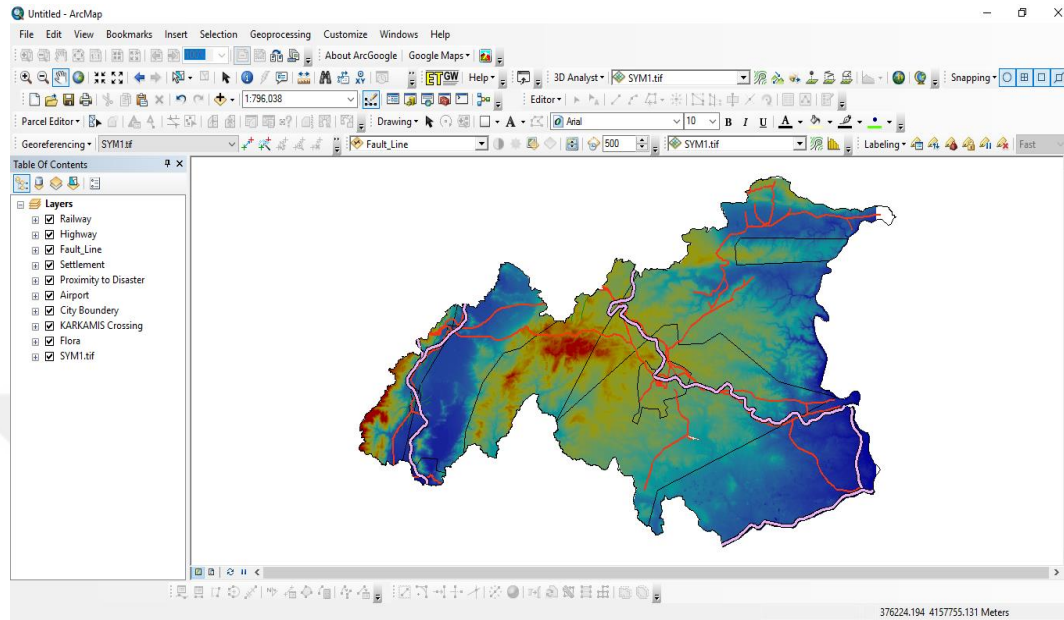


Figure 3.5 Examples of layers in ArcGIS

For some analyzes performed in ArcGIS, raster data was required. Since some data is not available in open access, data sets are generated from the maps provided in the raster extensions by means of the ArcGIS module. An example of using the map in raster format ArcGIS is given in Figure 3.6.

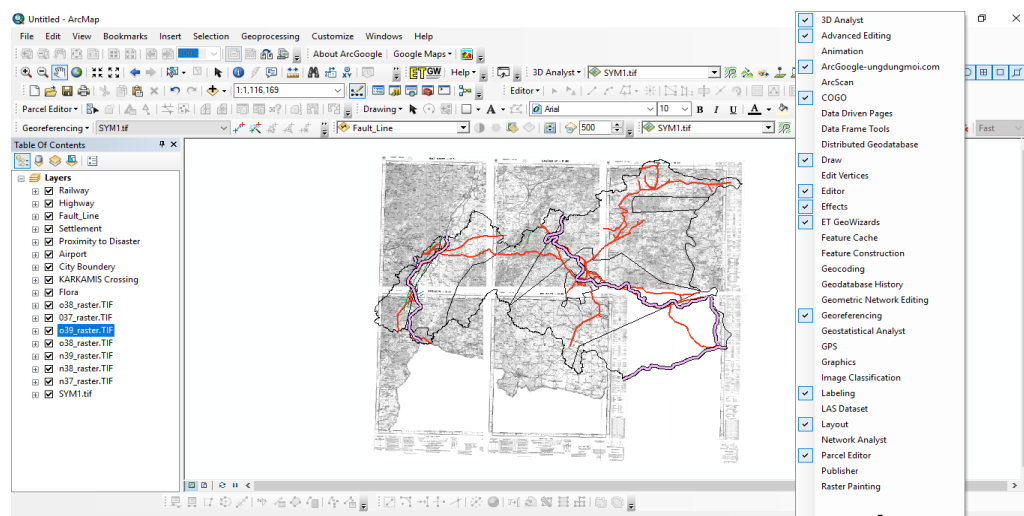


Figure 3.6 Example of using the map in raster format in ArcGIS

Adding a raster layer to a working environment or scaling allows you to point and digitize the required features on the map (Figure 3.6). It is possible to obtain data using Google Earth and specify it in the ArcGIS environment.

3.3.2 Conversion Toolbox

Since ArcGIS 10.2 is a software that allows complex calculations and analysis for various types of data, Conversion Toolbox assists in formatting the files extensions from one to another. Among many kinds of data extensions are; raster data (.jpg, .ncz, .png, .tiff), tables (.xlsx), feature class (polygons, point, lines), each of them might consist of various sets of values (Aitzhanov, 2016).

On the other hand, when it comes to classification, if the map is obtained in a raster environment and is also divided into designated regions, ArcGIS allows the classification of areas by specific values. Figure 3.7 shows the classified version of the scanning data in the example.

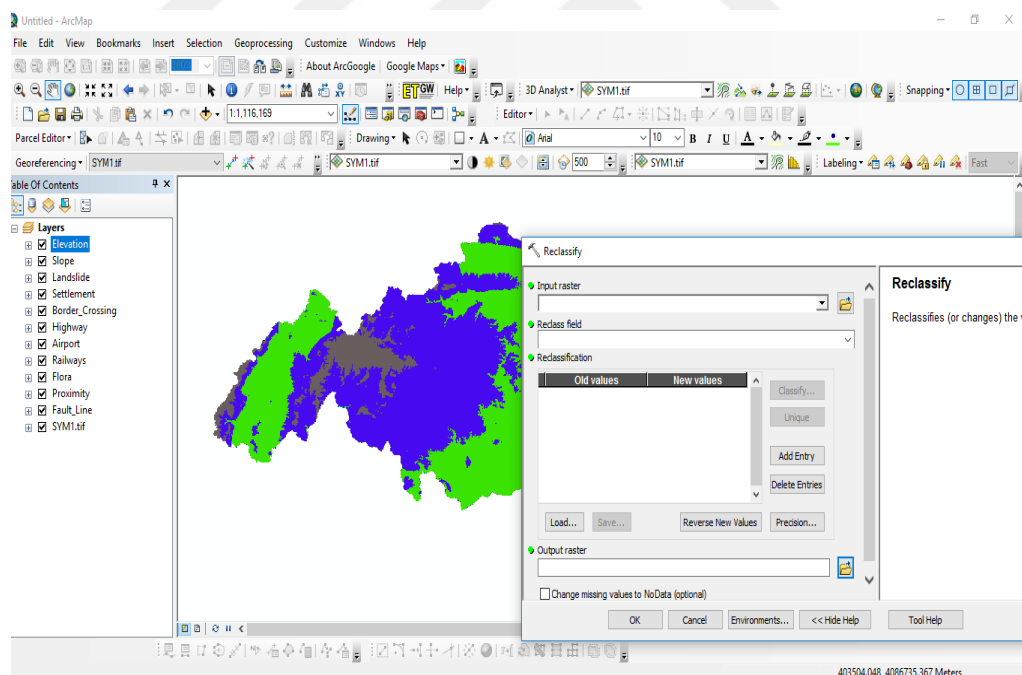


Figure 3.7 Raster data classification

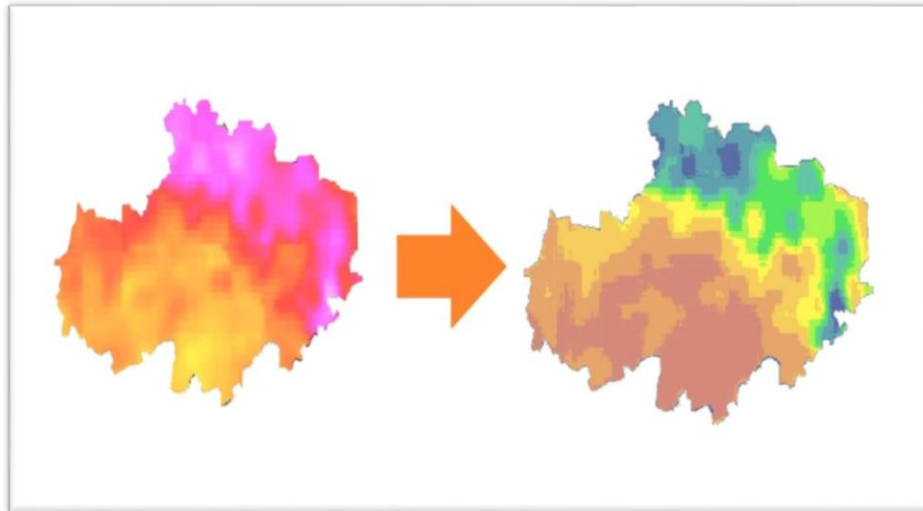


Figure 3.8 Output of classified function in ArcGIS

Figure 3.8 shows the output example of the classified function in ArcGIS.

3.3.3 Euclidean Distance

The Euclidian Distance function allows users to visualize all points that take place on a certain distance from a specified feature (road, lake, city, electricity line). In other words, in order to build and see buffer zones around particular object Euclidian Distance is the useful tool for this purpose (ESRI, 2019a). An example of the Euclidean Distance function output is shown in Figure 3.8. The map can be edited as desired using the properties of the layers to determine the boundaries of the buffer zone.

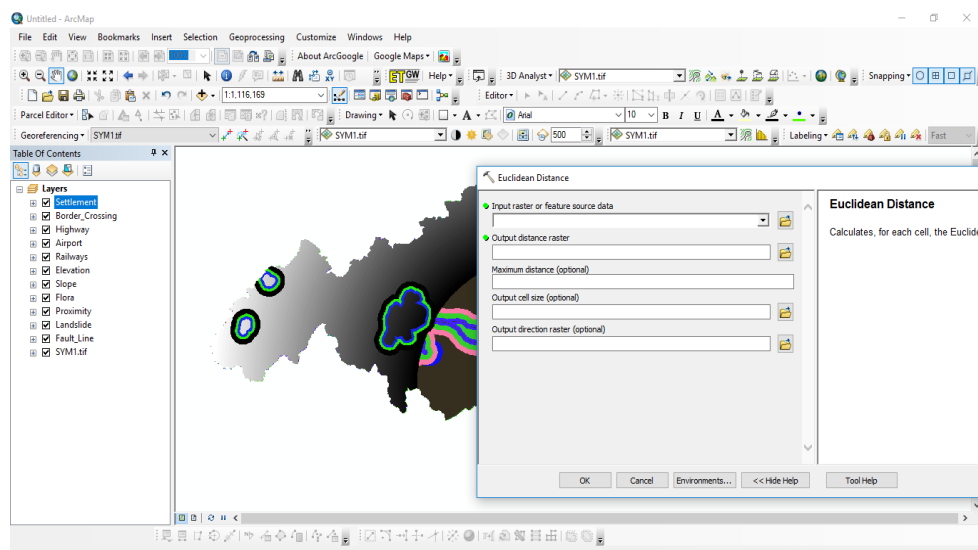


Figure 3.9 Euclidean Distance's function output

3.3.4 Reclassification

Before reclassifying the data, the buffer ranges should be classified by determining the distance ranges. Layer properties can be used to classify. To form a buffer zone, it can be made by dividing the fields into equal, defined, standard deviation or manual range. Number of classes can be edited or modified (Aitzhanov, 2016). Figure 3.10 shows an example of classification in ArcGIS.

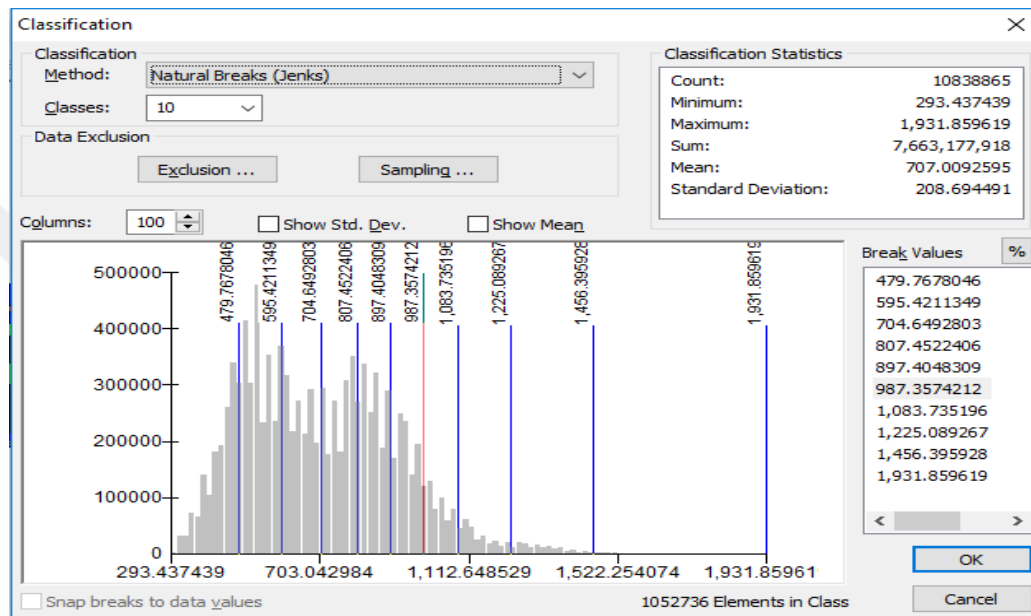


Figure 3.10 Classification Method Natural Breaks

3.3.5 Weighted Overlay

In general, during the performance of Weighted Overlay analysis, various raster assets are overlaid into one. Aggregation of these layers can be done utilizing weights obtained earlier or analysis can be process assuming that all layer are equally weighted (ESRI, 2019b).

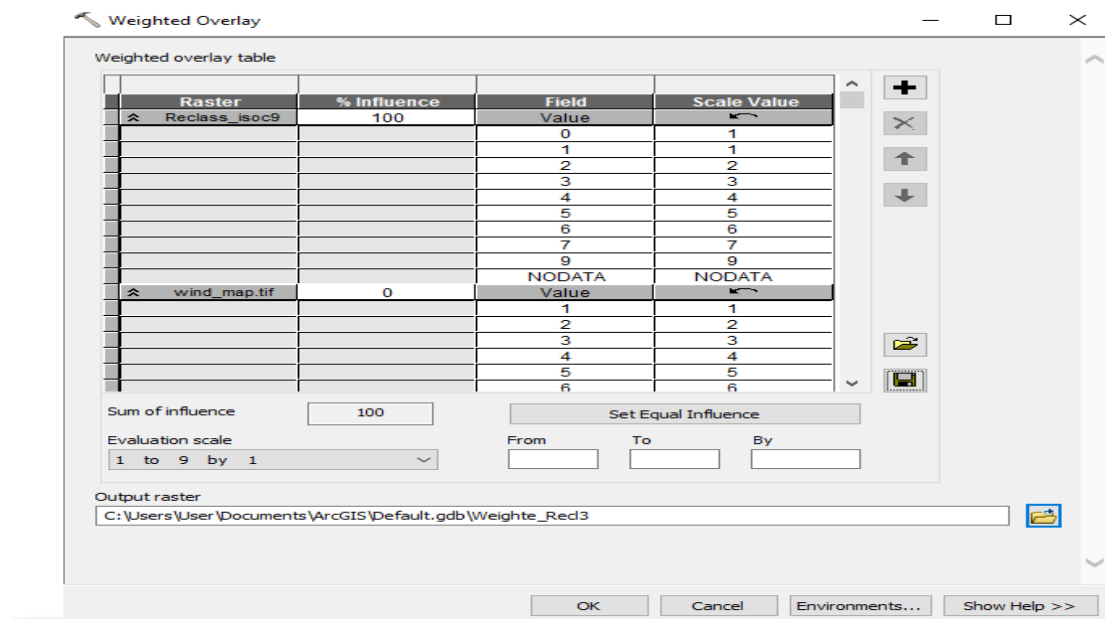


Figure 3.11 Dialog window of Weighted Overlay analysis

Figure 3.11 shows the window for the Weighted Overlay function. It allows the addition of as many layers as desired from the working environment and allows the user to calculate the weight of each layer in percent.

CHAPTER 4

LOCATION SELECTION ANALYSIS

4.1 Location Selection

Location selection is an important decision for the distribution, production, transportation, storage or delivery of the products that the organisations have given their service or sale. The term of the facility used in the location selection theorems can show as factory, school, commercial-industrial-public buildings. Location selection decisions often result in the identification, evaluation, and selection of multiple alternatives. Settlements such as social habitats, public housing, warehouses, shopping malls, airports and emergency service points locations are among the selected centers (Uslu, 2018).

There is a growing trend in the problems of location selection, in the academy and the business world day by day. It stands out as problems that need to be resolved together for researchers in different disciplines. The site selection is a process that requires many different settlement alternatives, multiple criteria and multiple phases to be thought together and moved in this way. In addition, decisions made during the selection of the location are given in a variable and movable environment. Some key factors may vary due to unexpected events. Likewise, under Multi-Criterion Decision Analysis, multiple selection places can prevail over alternatives. Each possible facility is advantageous in the proportion of its weight, but the decision to be made, all the criteria and alternatives must be considered together (Jun, 2000).

4.2 Proposed Methodology

In the study, two basic research methods, AHP method and ArcGIS program are used. With the AHP method of one of the MCDM methods, the criteria for the selection of the location are determined by the pairwise comparisons and the severity ratings of the weights. According to the severity of each major criterion and subcriteria, weights are calculated using the Expert Choice 11 program. Then, with ArcGIS 10.2 software,

the criteria are put into the analysis and in the result analysis, areas according to the suitability degree for disaster logistics warehouse location selection are determined.

4.3 Case Study Area (Gaziantep Province)

The study area covers Gaziantep province borders. Gaziantep province covers an area of 6,794 km². The population of Gaziantep province is 2.028.563 according to the results of 2018 address based population registration system (TÜİK, 2018). The proportion of residents in the city center is 88.7%, while the proportion of residents in the village is 11.3%. Gaziantep province is divided into 9 districts. The largest districts regarding population are Sahinbey, Sehitkamil, and Nizip. The smallest district in terms of population is Karkamis respectively.

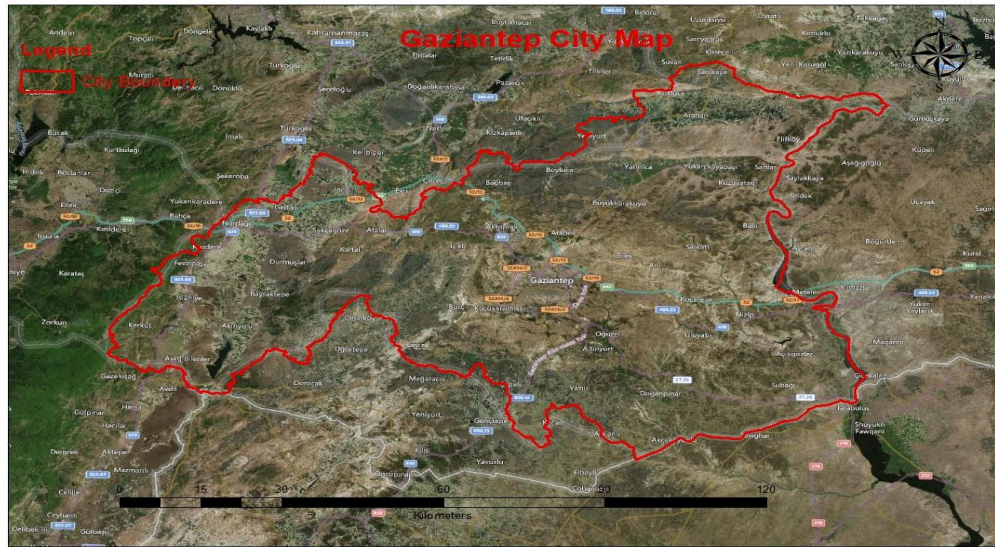


Figure 4.1 Gaziantep province open street map

There are several reasons for the selection of Gaziantep province in this study. Firstly, the center of Gaziantep province does not take place on any active fault. However, the earthquake risks of Nurdagi and Islahiye districts are very high and there is no major earthquake over the East Anatolian fault line in the Turkoglu-Antakya segment, which is approximately 145 km long passing through these districts, and the absence of a large earthquake for more than 150 years. Indicates how dangerous the area is in terms of the potential for earthquake generating. In addition, as a result of internal turmoil in Syria, it is envisaged to establish a disaster logistics warehouse in order to alleviate the damages and meet the needs of Syrian citizens who came to Gaziantep city since

March 2012. Also, Gaziantep is a very important place in Turkey's industry and trade as it is one of the most developed cities in the Southeastern Anatolia region and the most populated metropolitan area between Turkey's southeastern Anatolia and the Mediterranean region. Also Gaziantep is located between Anatolia and the Middle East, it is close to the port towns and to the Silk Road.

4.4 Disaster Logistics Warehouse Site Selection Technique

After establishing the hierarchy of criteria for the location selection of the disaster logistics warehouse installation area, all criteria are weighted according to experts' opinion. Then, the data sets of the criteria are analyzed by using ArcGIS software. The applied methodology can be seen in Figure 4.2.



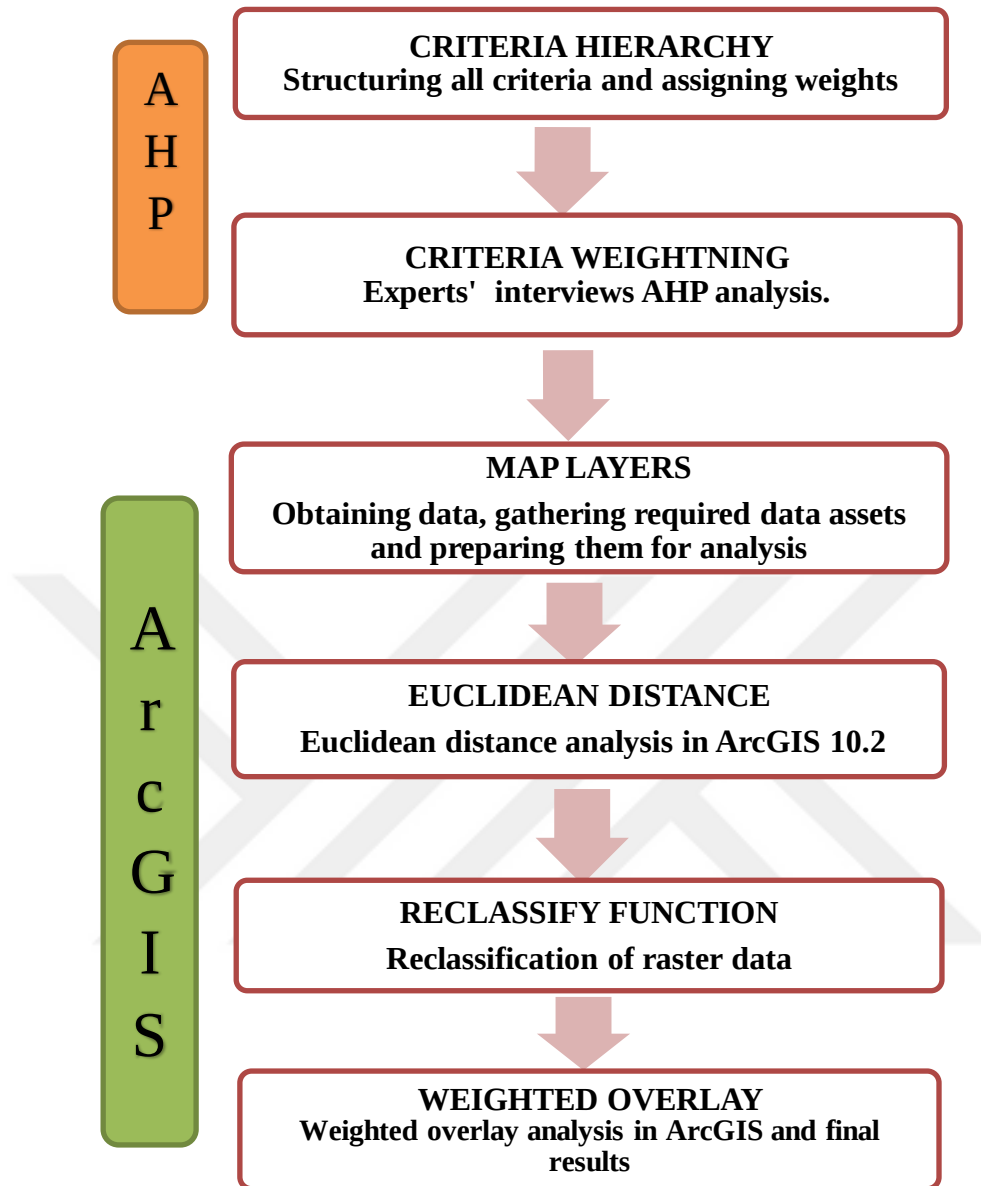


Figure 4.2 General scheme of the present study and steps of analysis procedures

4.4.1 Determination of Site Selection Criteria for Disaster Logistics Warehouse

The criteria in the decision-making process are measurable values that characterize the area related to the problem that is used to determine the most appropriate alternatives and to reach a judgment. In this study, the selection criteria of disaster logistics warehouse are determined according to the opinions of AFAD seven experts taking into account the characteristics of the region and the literature studies. A total of eleven (11) sub-criteria under three (3) main criteria, are determined for the study. The AHP hierarchy model is given in Figure 4.3.

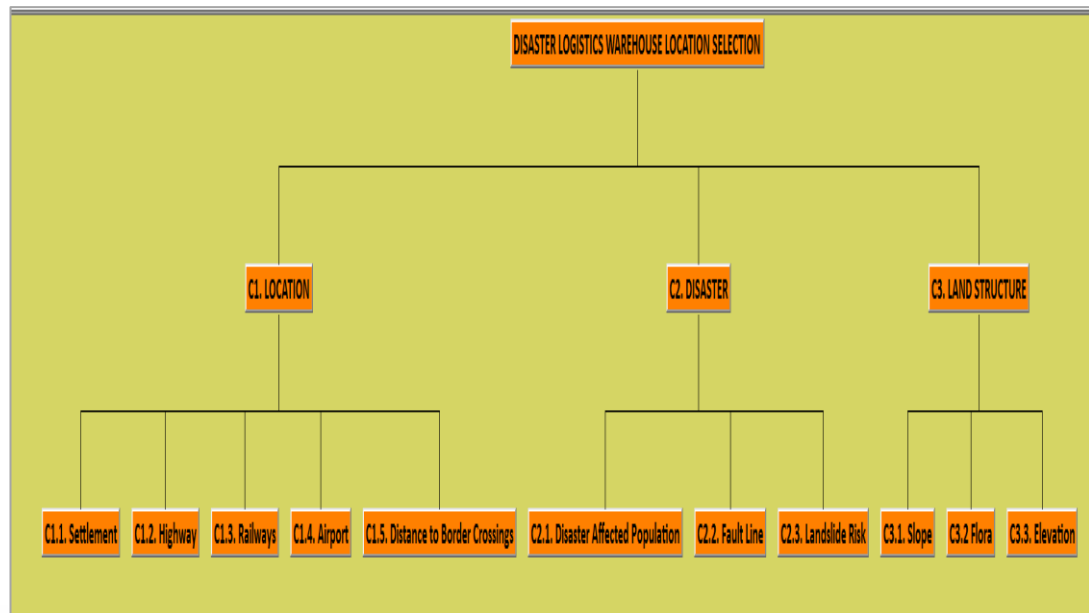


Figure 4.3 AHP hierarchy model

Description of Each Criterion;

C1. Location

C1.1. Settlement Distance: Disaster logistics warehouse location to be selected should be close to the settlement.

C1.2. Highway Distance: In order to transport the materials to the desired location in a short time and with less cost, the location of the disaster logistics warehouse should be close to the highways.

C1.3. Railways Distance: In order to transport the materials to the desired location in a short time and with the lower cost, the location of the disaster logistics warehouse should be close to the railways.

C1.4. Airport Distance: Disaster logistics warehouse location should be close enough to the airport in order to reach the desired materials in a short time.

C1.5. Distance to Border Crossings: In order to deliver humanitarian supplies that may be needed in Syria in a short period of time, the disaster logistics warehouse location to be selected should be located close enough to the border gate.

C2. Disaster

C2.1. Proximity to Disaster Affected Population: Disaster logistics warehouse location to be selected should be close to the proximity to disaster affected population.

C2.2. Distance to Fault Line: The area where the disaster logistics warehouse will be established should be at a sufficient distance from the fault line.

C2.3. Landslide Risk: Disaster logistics warehouse to be installed should be away from the areas of landslide risk.

C3. Land Structure

C3.1. Slope: Due to the construction cost will be higher in high slope areas, the slope percentage of the area where the disaster logistics warehouse will be installed needs to be low.

C3.2. Flora: The vegetation density of the area where disaster logistics warehouse will be established needs to be low.

C3.3. Elevation: The area where the disaster logistics warehouse will be established needs to have a low elevation. The AHP hierarchy model is given in Figure 4.4.

4.4.2 Weighting the Criteria with AHP Method

Each criteria requires a certain weight to perform Overlay Analysis in ArcGIS. With the AHP method, which is one of the methods of MCDM, the pairwise comparisons of the criteria are used for the most frequently used location selection process. The weights of each main criterion and sub-criteria are calculated using the Expert Choice 11 program. Three main criteria and eleven sub-criteria are used for the calculation process.

Table 4.1 Table of importance scale used in pairwise comparison (Saaty, 1980)

Intensity	Definition	Explanation
1	Equal importance	Two barriers contribute equally to the goal
3	Moderate importance	Experience and judgement slightly favours the one over the other
5	Essential or strong importance	Experience and judgement strongly favours the one over the other
7	Demonstrated importance	Dominance of the demonstrated in practice
9	Extreme importance	Evidence favouring the one over the other of highest possible order of affirmation
2,4,6,8	Intermediate values	When compromise is needed

The matrix of pairwise comparisons between them is made for the main and sub-criteria. These matrices were prepared through the significance scale used in binary comparison was established according to Table 4.1 as a result of the opinions of seven experts working in disaster logistics warehouse location selection in AFAD.

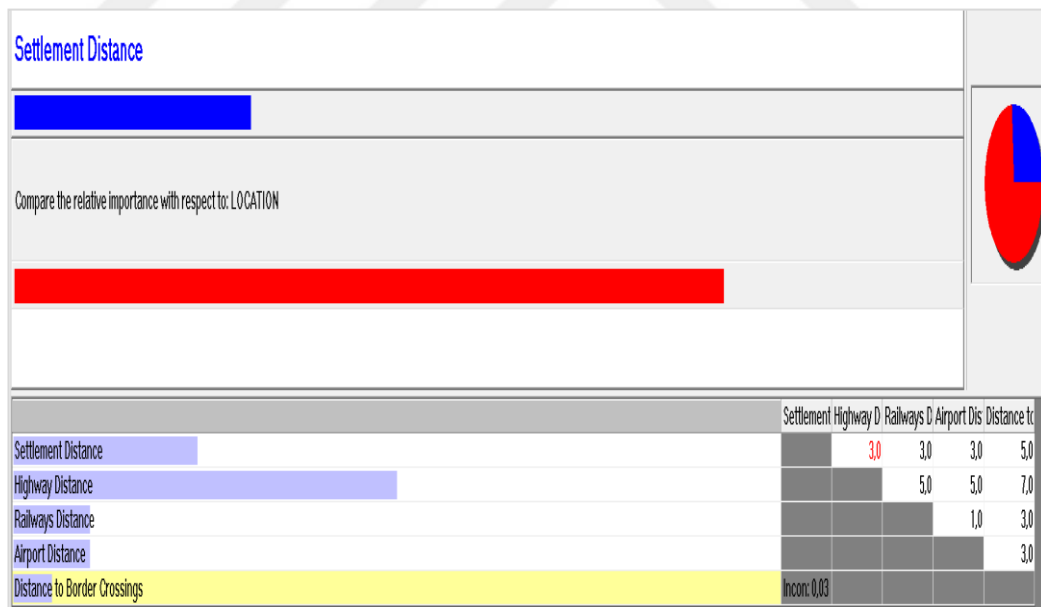


Figure 4.4 Graphical representation of matrix created for location

The main criteria location matrix created can be seen in Figure 4.4. The Tables of pairwise comparisons for the main and sub criteria and the results of the other matrix for the criteria are included in the appendices of the study. The weights of each main criterion and sub-criterias are calculated using the pairwise comparison matrixes. The

in consistency ratios of the pairwise comparison matrix are found below 0.10. The results obtained by using the Expert Choice program as a result of the interviews with experts are given in the tables below. Weights of the main criteria that calculated by the Expert Choice Program are shown in Figure 4.5.

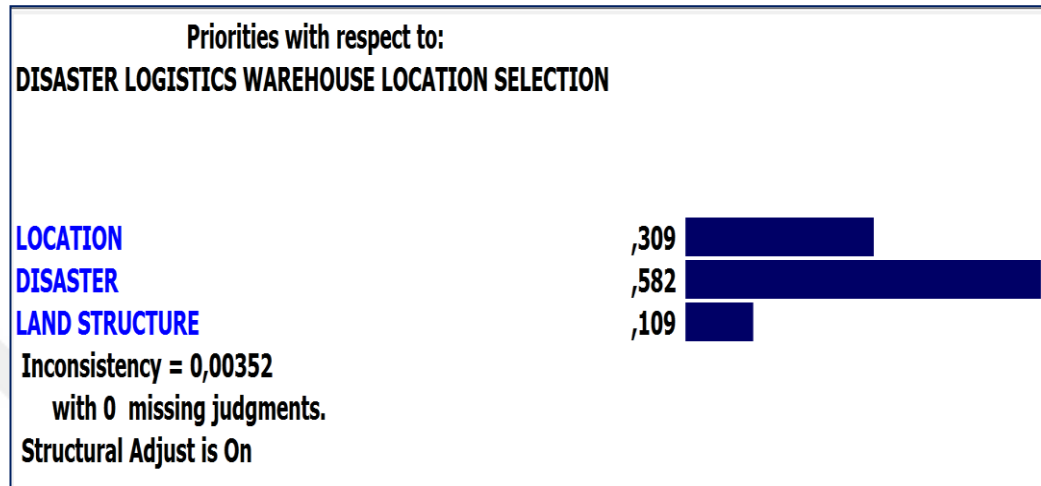


Figure 4.5 Weights and consistency ratios of the main criteria

The weights of the sub criteria under the position main criterion calculated by the Expert Choice Program are shown in Figure 4.6.

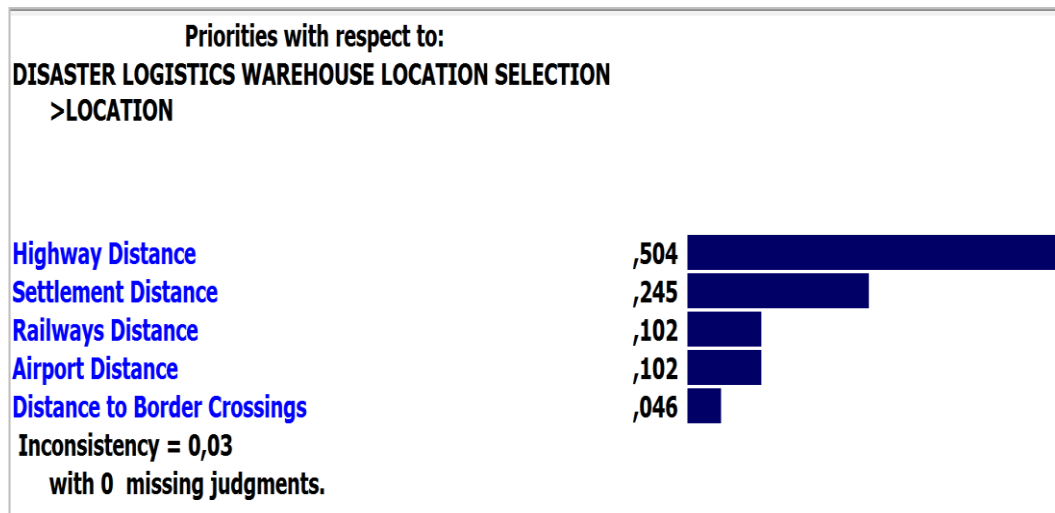


Figure 4.6 Weights and consistency ratios of the main criteria “Location”

The weights of the sub-criteria, which are calculated under the Expert Choice program are shown in Figure 4.7.

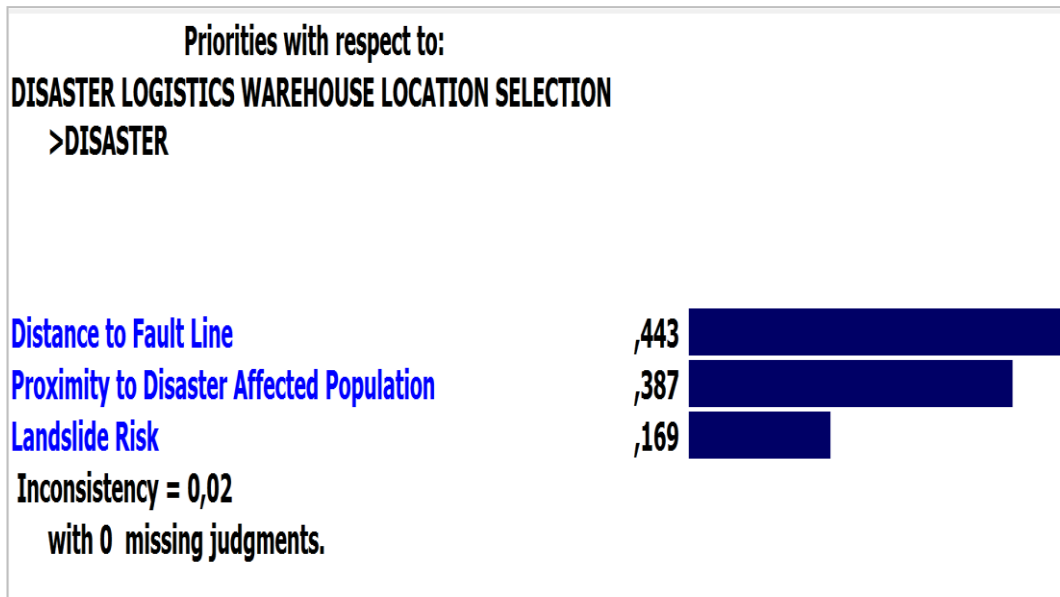


Figure 4.7 Weights and consistency ratios of the main criteria “Disaster”

The weight of the sub-criteria under the land structure main criterion calculated by the Expert Choice Program is shown in Figure 4.8.

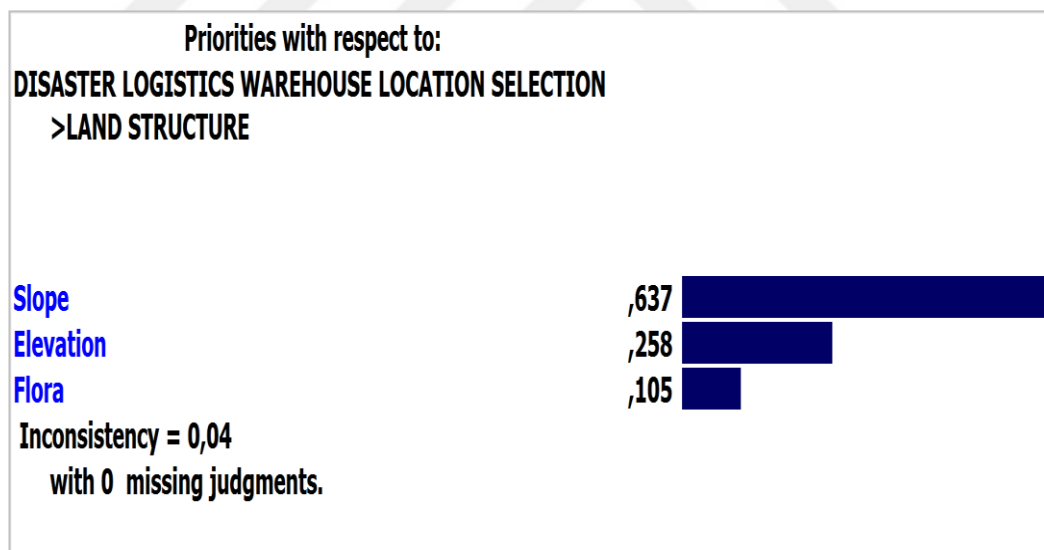


Figure 4.8 Weights and consistency ratios of the main criteria “Land sructure”

The weights of the 11 sub-criteria that calculated by the Expert Choice program are shown in Figure 4.19.

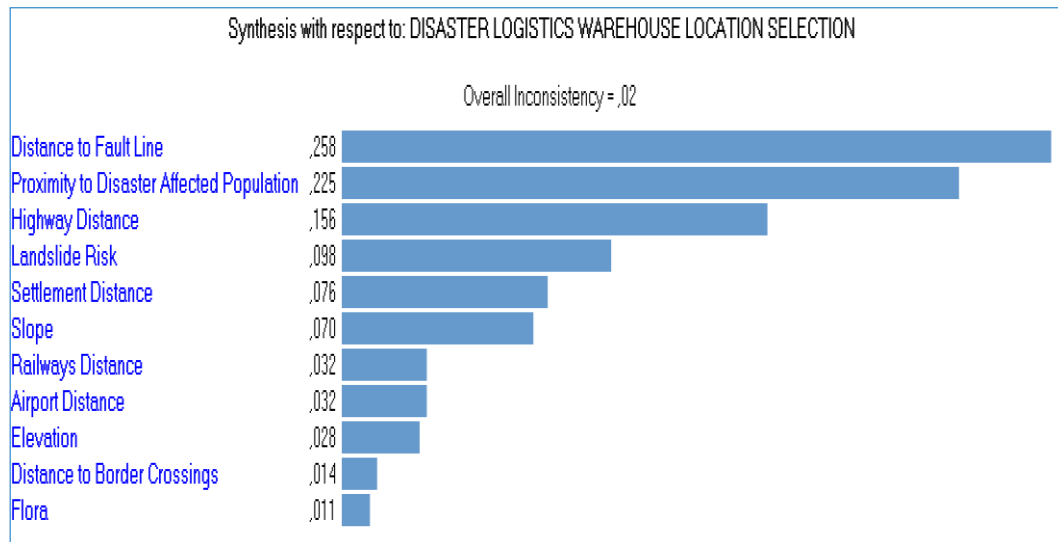


Figure 4.9 Weights and consistency of all sub-criteria used in the study

The percentage of the weights of the 11 sub-criteria that calculated by the Expert Choice Program is shown in Figure 4.10.

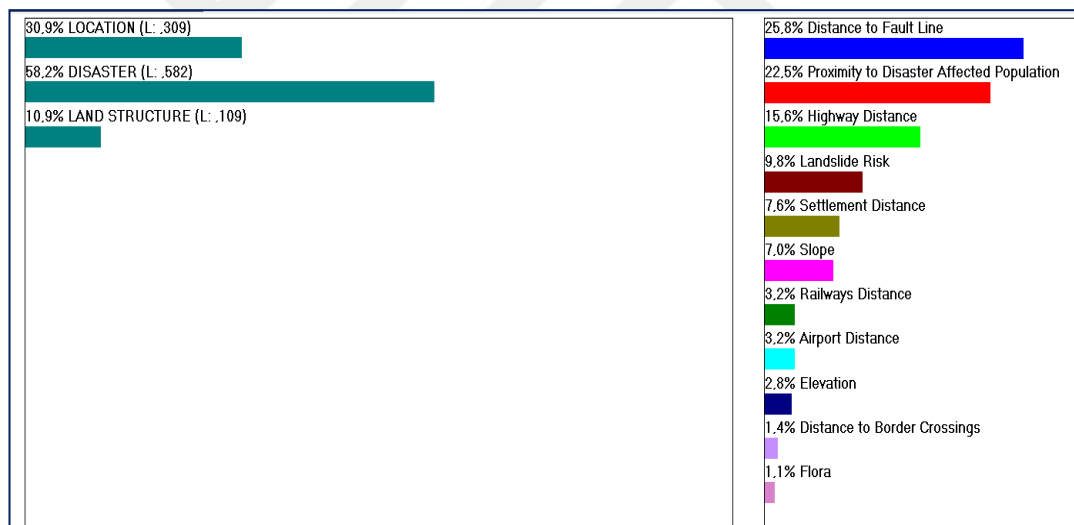


Figure 4.10 Percentages of weights of all sub-criteria used in the study

The weights of the criteria calculated by the AHP can be seen in Figure 4.10. The consistency ratio (CR) 0.02 is calculated as a result of the pairwise comparisons made for the sub-criteria. Since the CR value is less than 0.10, it can be mentioned, that the obtained results are reliable. According to Figure 4.11, the most important criterion is determined as the fault line with **25.8%**. AHP is a decision making process that is based on criteria of relative importance. The matrices created for the sub-criteria were

formed as a result of the opinions of experts, who are working at AFAD, on the selection of the location of the disaster logistics warehouse.

According to the sub-criteria weights that calculated by AHP, the fault line (25.8%), proximity to disaster affected population (22.5%) and highway distance (15.6%) have been determined as the three most important criteria. Due to the places close to the fault line will be affected more in an earthquake that may occur in Gaziantep province, it is vital that the area where the disaster logistics warehouse will be established is located at a sufficient distance from the fault line. Therefore, it is considered that the most important criterion is determined by the experts, who are working on disaster logistics warehouse location selection at AFAD. In case of any possible earthquake, quick and low-cost delivery of the necessary assistance to the affected people is considered by AFAD experts in terms of ranking, proximity to disaster affected population as second and highway distance as third sub-criteria. Assessing the obtained results, the vegetation density of the area where the disaster logistics warehouse will be established was determined by AFAD experts as the least important sub-criterion by 1.1%.

4.4.3 Site Selection with GIS Analysis

As described in Chapter 3, GIS is a complex structure that stores, analyzes and manages all kinds of spatial and geographic data. In the present study, ArcGIS 10.2 software is used to create data sets, to create map data and to perform certain analyzes with the help of data sets.

4.4.3.1 Map Layers and Resources

In this study, data layers of the selected criteria are required to complete the analysis using the GIS technique. The list of map layers required for the study is shown in Table 4.1. For each sub-criterion, a separate map layer is created which are downloaded from open sources or drawn based on existing maps online. Because some maps are only available in ".shp" ".mdb" ".ncz" ".jpg" ".png" or ".tiff" extensions, they are converted using Conversion ArcToolbox in ArcGIS. The conversion Toolbox has a wide variety of functions. Although Arcgis is a complex system that allows multi-perspective analysis with a variety of data types, it can convert a data type to another using

conversion tools. Specifically, for the study, raster data has been transformed and analyzed, so it will be available in later reviews. These map layers, created from raster files such as ".jpg" or ".png", are directly plotted as feature data extensions in the ArcGIS 10.2 software.

Table 4.2 List of map layers needed for current research

No	Main Criteria	Sub-Criteria	Map Needed
1	C1. Location	C1.1. Settlement Distance	Map of Gaziantep city center, Islahiye and Nurdagi district centers
		C1.2. Highway Distance	Gaziantep province map of highway network
		C1.3. Railways Distance	Gaziantep province map of railways network
		C1.4. Airport Distance	Map of airport in the region
		C1.5. Distance to Border Crossings	Karkamis border crossing map
2	C2. Disaster	C2.1. Proximity to Disaster Affected Population	Map of Gaziantep city center, Islahiye and Nurdagi district centers
		C2.2. Distance to Fault Line	Gaziantep province fault line map
		C2.3. Landslide Risk	Gaziantep province landslide risk map
3	C3. Land Structure	C3.1. Slope	Gaziantep province slope map
		C3.2. Flora	Gaziantep province flora map
		C3.3. Elevation	Gaziantep province elevation map

Table 4.2 shows the map layers for all site selection criteria selected for this study. These map layers are required to create a disaster logistics warehouse location selection area. GIS data sets for the workplace (settlements, highways, airports, railways, border crossing, fault line map, landslide risk map, slope, elevation, flora) are collected from different sources as shown in Table 4.3. Most of the data are obtained by digitizing from Digital Elevations Models (DEM) 1:25000 scale maps. All this data has been converted to raster format using ArcGIS software.

Table 4.3 List of data layers used in current study

No	Map Needed	Source
1	Map of Gaziantep city center, Islahiye and Nurdagi district centers	Metropolitan Municipality of Gaziantep
2	Gaziantep province map of highway network	General Directorate of Highways
3	Gaziantep province map of railways network	General Directorate of State Railways
4	Map of airport in the region	Created Using Google Earth Maps
5	Created Using Google Earth Maps	Created Using Google Earth Maps
6	Map of Gaziantep city center, Islahiye and Nurdagi district centers	Geographic Map of Gaziantep Region
7	Gaziantep province fault line map	(AFAD, 2019d)
8	Gaziantep province landslide risk map	(Gaziantep AFAD, 2019a)
9	Gaziantep province slope map	(ASTER GDEM, 2019)
10	Gaziantep province flora map	(Gaziantep AFAD, 2019b)
11	Gaziantep province elevation map	(ASTER GDEM, 2019)

4.4.3.2 Euclidean Distance and Reclassify Criteria for Site Selection

The weights of the criteria selected for site selection by AHP method are made in the previous section. The sub-criteria determined for the study are based on distance or proximity to the site selection area, and based on the previous site selection studies in the literature, distance-based scoring maps are created with ArcToolbox> Spatial Analyst Tools> Distance> Euclidean Distance tool. For the criteria, 3 classes are created in the GIS according to the distance of the site selection area, and the class intervals are scored between 0 and 5 (0 lowest, 5 highest).

4.4.3.3 Distance to Settlement

Disaster logistics warehouse location to be selected should be close to the settlement. To avoid an investment to the infrastructure (drinking water, sewage, electricity, etc.) of the disaster logistical warehouse to be made, the proximity to the settlement should be taken into consideration. In consideration of the developments in the study, the

restriction value for the areas close together with the settlement areas is set to < 1000 m. According to distances from the settlement, the values of the GIS class are 1000-2000m 3 points, 2000-3000m 2 points and 3000-5000m 1 points respectively (Güler, 2017). The Figure 4.11 shows the borders of centrum of Gaziantep and centrum of its districts Islahiye and Nurdagi.

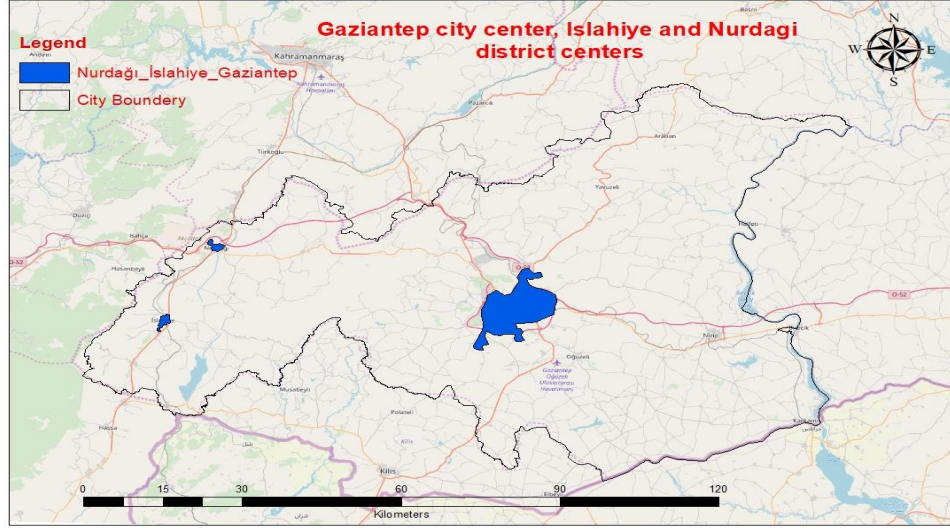


Figure 4.11 Map of Gaziantep city center, Islahiye and Nurdagi district centers

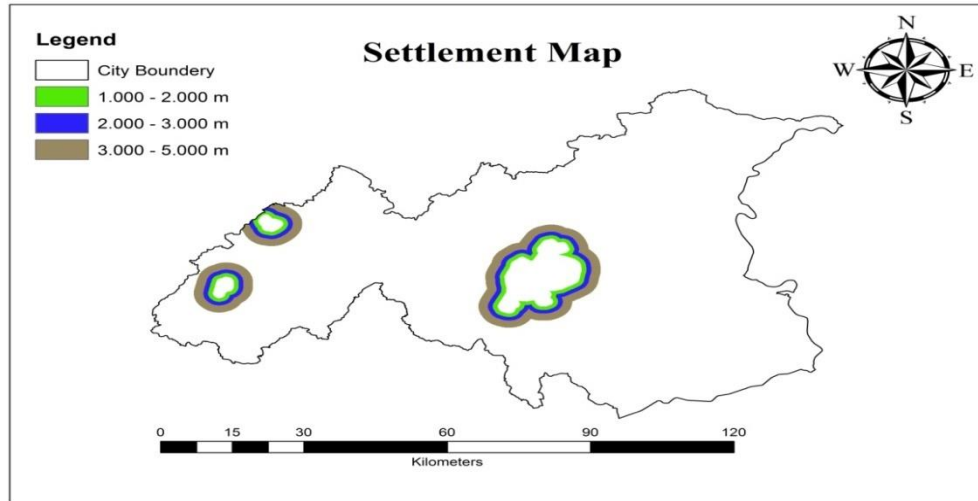


Figure 4.12 Map of settlement prepared by classification process in ArcGIS

In Figure 4.12, according to the criteria specified in the ArcGIS software reclassification process is prepared by the map of the location data layer is seen.

4.4.3.4 Highway Distance

In order to transport the materials to the desired location in a short time and with less cost, the location of the disaster logistics warehouse should be close to the highways. Gaziantep Province is an important crossing point with land transportation facilities. Road transportation from the south and the sea to the east and north of the E-90, D-52, D-54, D-400, D-850 highways are provided to the city. According to the distances, the GIS class values are 50-1000 m 3, 1000-3000 m 2 and 3000-5000 m 1 point respectively (Uyan, 2013), Figure 4.13 has a road map of Gaziantep province.

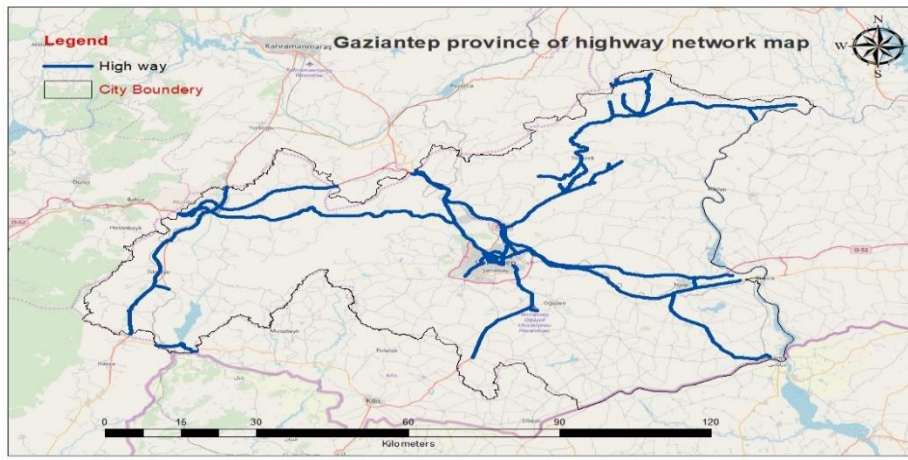


Figure 4.13 Gaziantep province map of highways network

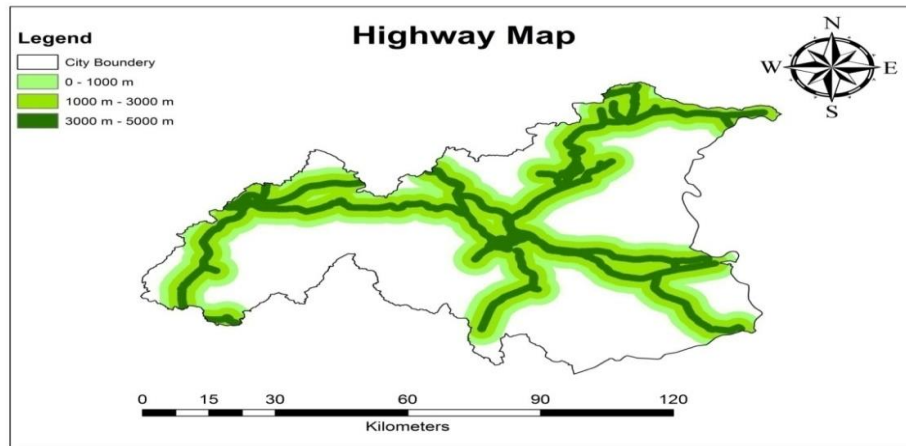


Figure 4.14 Highways map prepared by classification process in ArcGIS

In Figure 4.14, according to the criterion values determined by the ArcGIS software reclassification process is prepared by the road data layer map is seen.

4.4.3.5 Railways Distance

In order to transport the materials to the desired location in a short time and with lower cost, the location of the disaster logistics warehouse should be close to the railways. Therefore, according to the railway distances, the GIS class values are 0-3000 m 5 points, 2000-3000 m 3 points and 5000-100000 m 1 points respectively (Atıcı et al., 2015). There is a railway map of Gaziantep which can be seen in Figure 4.15.

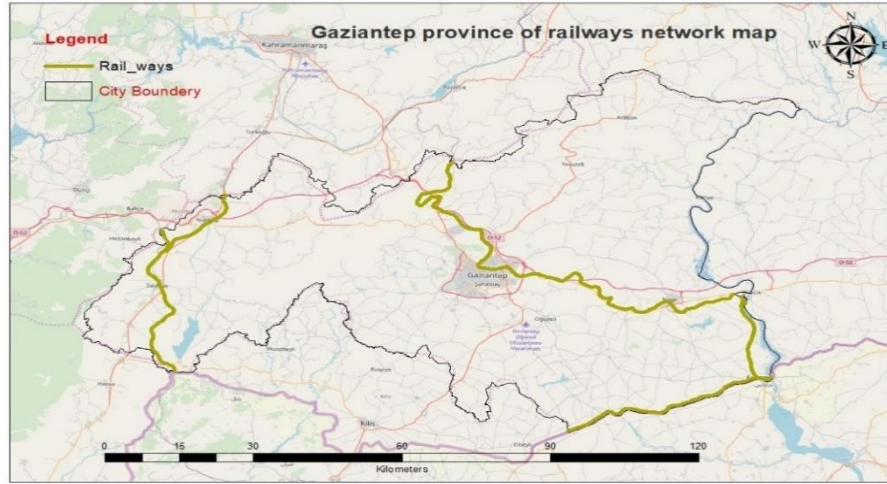


Figure 4.15 Gaziantep province map of railways network

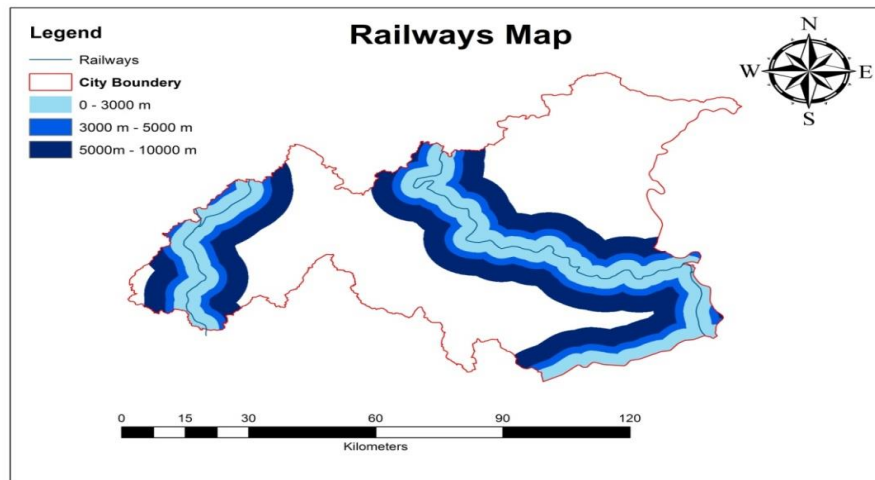


Figure 4.16 Railways map prepared by classification process in ArcGIS

In Figure 4.16, according to the criterion values shown by the ArcGIS software reclassification process is prepared by the railway data layer map is seen.

4.4.3.6 Airport Distance

Disaster logistics warehouse location should be close enough to the airport in order to reach the desired materials in a short time. There is an airport available in Gaziantep province. Gaziantep Oguzeli airport is located 20 km from the city centre. According to the distance to the airport, the GIS class values were 1000-3000 m 5 points, 3000-5000 m 3 points and 5000m > 1 points respectively (Güler, 2017).

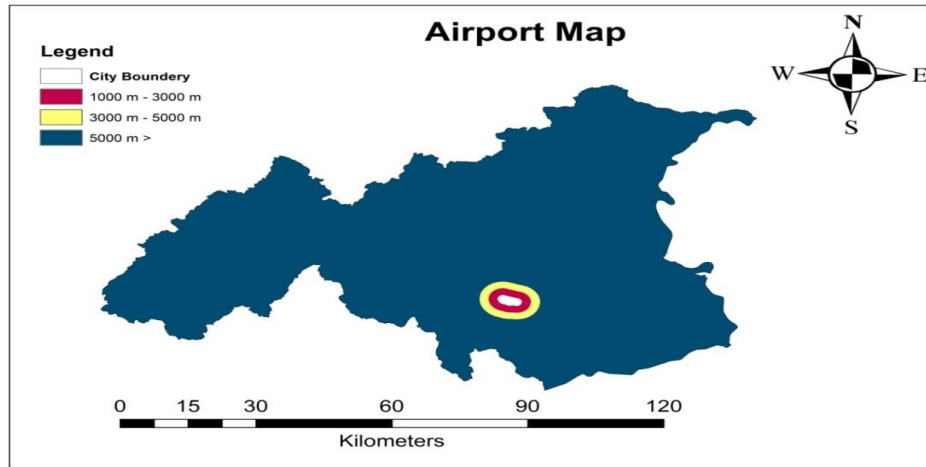


Figure 4.17 Airport map prepared by classification process in ArcGIS

In Figure 4.17, according to the criteria specified in the ArcGIS software reclassification process is prepared by the airport data layer map is seen.

4.4.3.7 Distance to Border Crossings

In order to deliver humanitarian supplies that may be needed in Syria in a short period of time, the disaster logistics warehouse location to be selected should be located close enough to the border gate. There is a Karkamis border crossing between Turkey and Syria in Gaziantep province, and the distance to Gazianep province is 85 km. According to the border crossing distances, the class values of the GIS 50000-75000 points m 3, 75000-100000 m 2 points and 100000 m > 1 points respectively (Expert opinions on site selection). Figure 4.18 shows a map of the Karkamis border crossing in Gaziantep province.

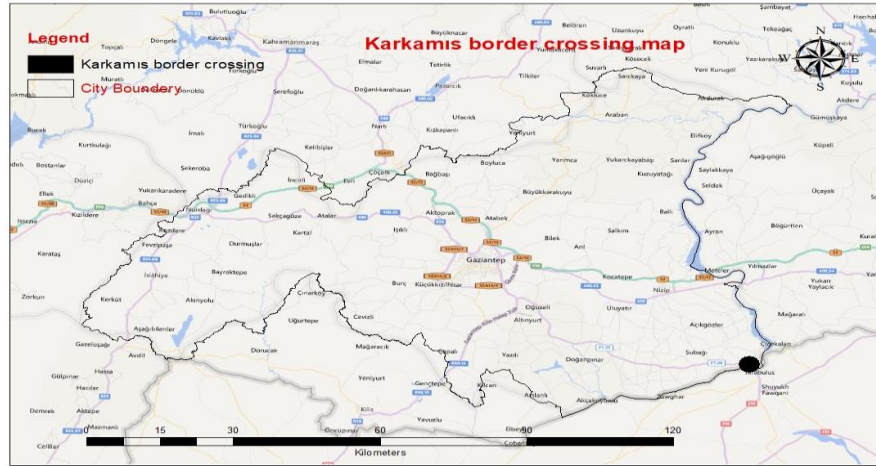


Figure 4.18 Karkamis border crossing map

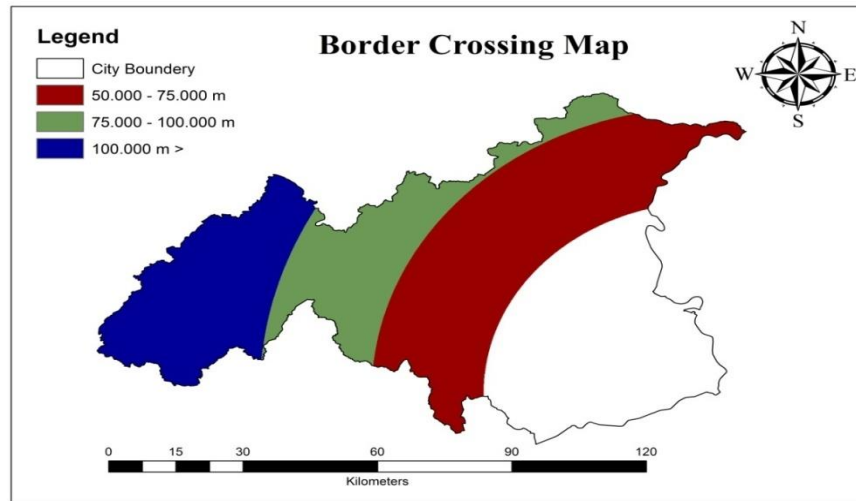


Figure 4.19 Border crossing map prepared by classification process in ArcGIS

In Figure 4.19, according to the criterion values determined by the ArcGIS software reclassification process is prepared border crossing data layer map is seen.

4.4.3.8 Proximity to Disaster Affected Population

Disaster logistics warehouse location to be selected should be close to the proximity to disaster affected population. Gaziantep provincial center does not take place on any active fault. Gaziantep province Gaziantep city center Nurdagi and Islahiye districts in an earthquake that could be a very high earthquake acceleration of the value of the people living within the boundaries of this study is evaluated as potential sheltered (AFAD experts opinions). Figure 4.20 shows the map of Gaziantep provincial center Nurdagi and Islahiye district centers.

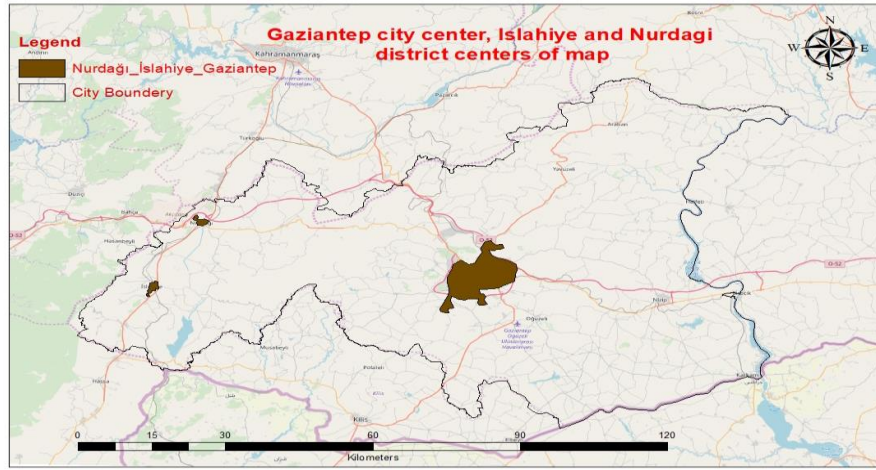


Figure 4.20 Map of Gaziantep city center, Islahiye and Nurdagi district centers

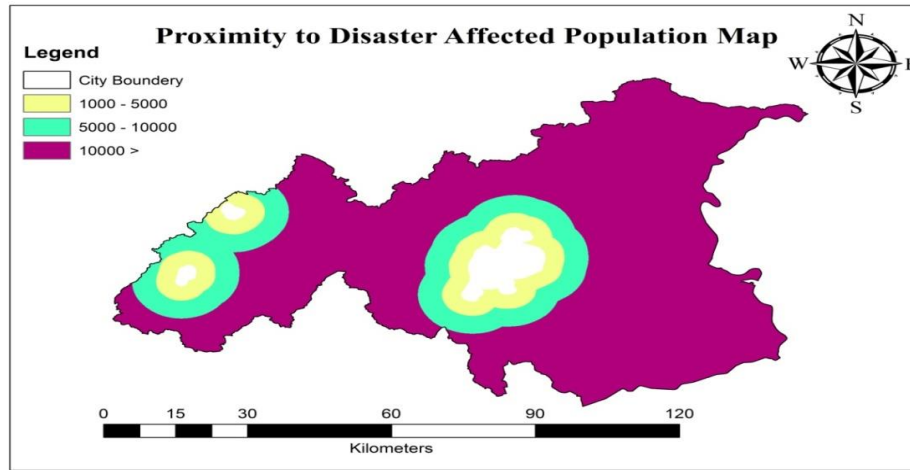


Figure 4.21 Disaster affected population map prepared by process in ArcGIS

In Figure 4.21, according to the criteria specified in the ArcGIS software reclassification process prepared by the Gaziantep provincial center Nurdagi and Islâhiye district centers data layer map is seen.

4.4.3.9 Distance to Fault Line

The area where the disaster logistics warehouse will be established should be at a sufficient distance from the fault line. Gaziantep provincial center does not take place on any active fault. However, the Eastern Anatolian fault line, which is approximately 145 km long, passes through the districts of Nurdagi and Islahiye. According to the distance distances of the fault line, the values of the GIS class 18000-20000 m 1points, 20000-40000 points m 3 and 40000 m > 1 points respectively (Sonmez, 2011). Figure 4.22 shows the map of the fault line in Gaziantep province.

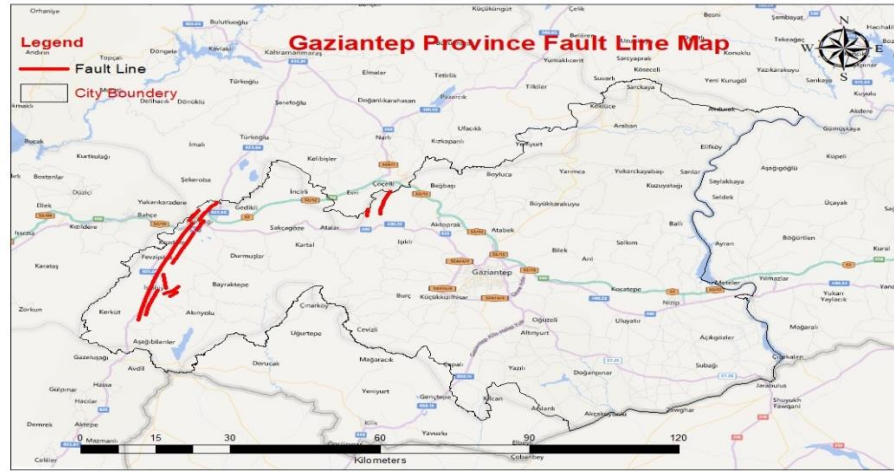


Figure 4.22 Gaziantep province fault line map

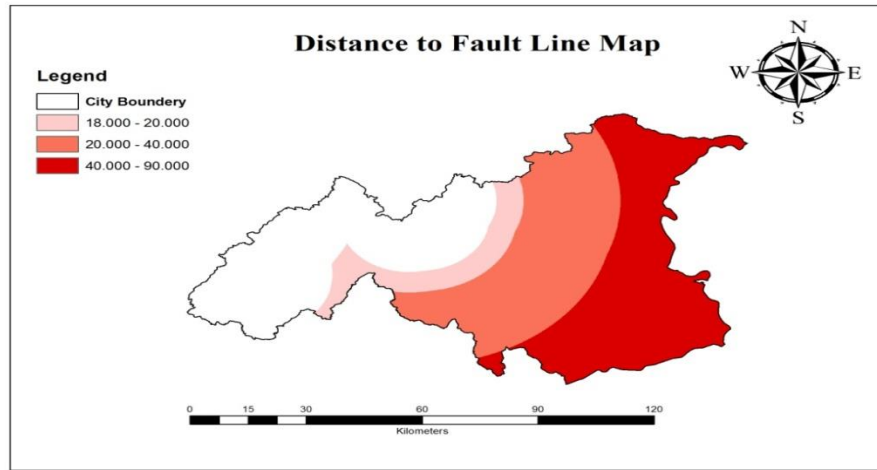


Figure 4.23 Fault line map prepared by classification process in ArcGIS

In Figure 4.23, according to the criteria specified in the ArcGIS software reclassification process is prepared by the data layer map of the fault line Gaziantep province.

4.4.3.10 Landslide Risk

Disaster logistics warehouse to be installed should be away from the areas of landslide risk. The GIS class values are given a very low risk (0-80) 5 points, low risk (80-160) 3 points and moderate risk (160-240) 1 points respectively, considering the risk of landslides (Gaziantep AFAD, 2019a). Figure 4.24 has a landslide risk map in Gaziantep province.

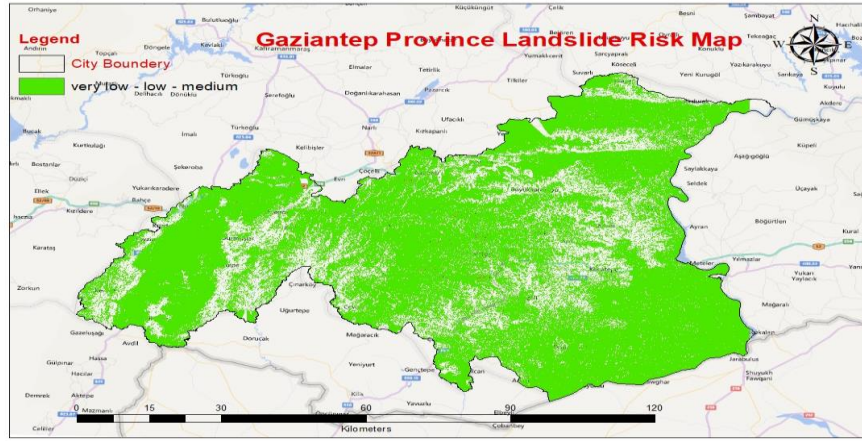


Figure 4.24 Gaziantep province landslide risk map

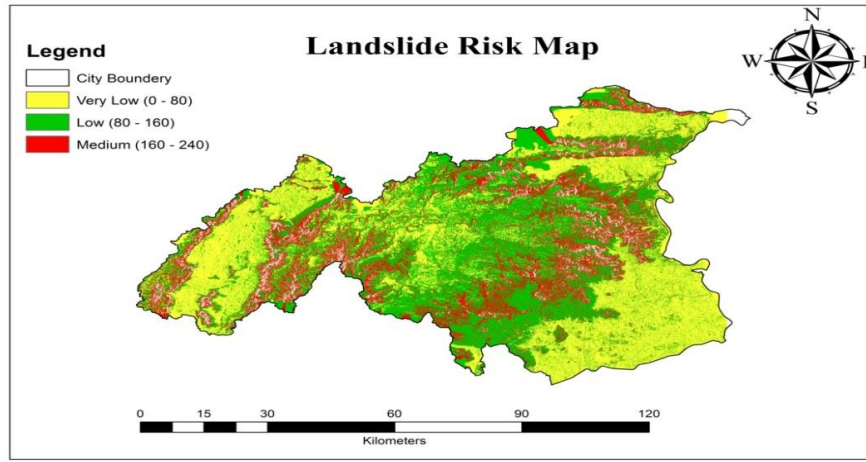


Figure 4.25 Landslide risk map prepared by classification process in ArcGIS

In Figure 4.24, according to the criteria specified in the ArcGIS software reclassification process prepared by the Gaziantep province landslide risk data layer map is seen.

4.4.3.11 Slope

Construction costs are increasing in areas with high slope. A numerical elevation model is created from the topographic map with 5 m spacing curves of the region using ArcGIS software. In consideration of the slope criterion, the GIS class values are 0-1% 5 points, 1-3 % 3 points and 3% > 1 points respectively. Figure 4.26 shows the slope map of Gaziantep province (Uyan, 2013).

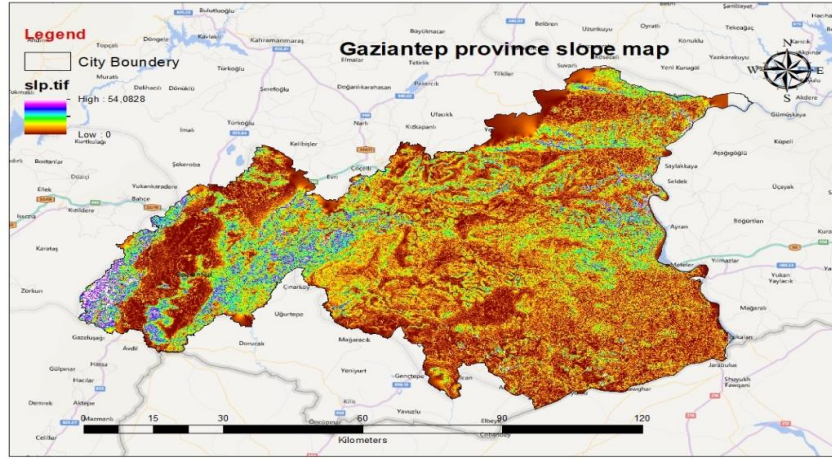


Figure 4.26 Gaziantep province slope map

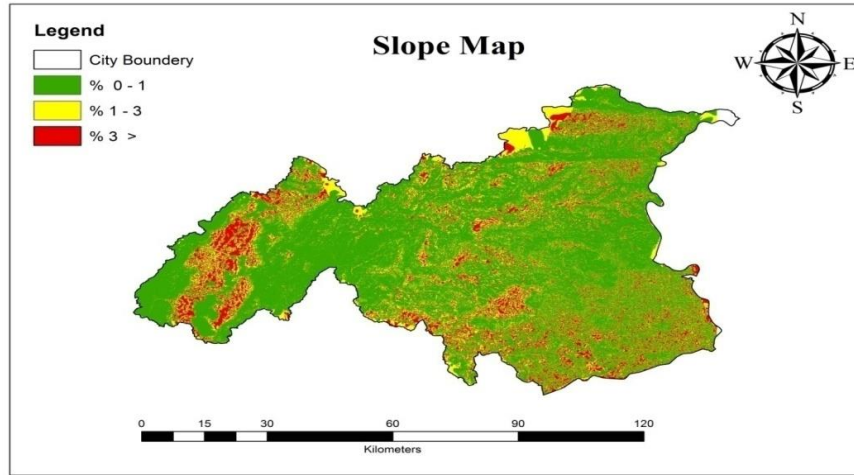


Figure 4.27 Slope map prepared by classification process in ArcGIS

In Figure 4.27, according to the criteria specified in the ArcGIS software reclassification process prepared by the Gaziantep province slope data layer map is seen.

4.4.3.12 Flora

From the vegetation map belonging to the working area, places with pastures, large leafy trees, maki and steppe are identified. Considering the species of vegetation, the values of the GIS class are given 0-800 m 1 points, 800-10000 m 2 points and 10000 m 3 points respectively (Expert opinions on site selection). Figure 4.28 shows the map of the vegetation in Gaziantep province.

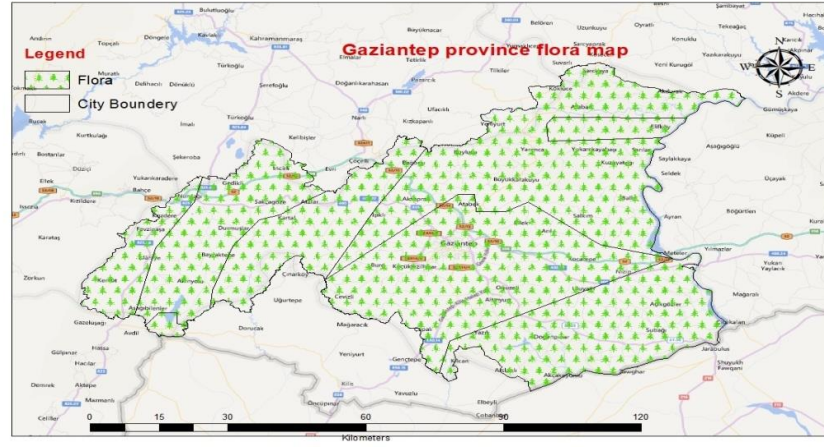


Figure 4.28 Gaziantep province flora map

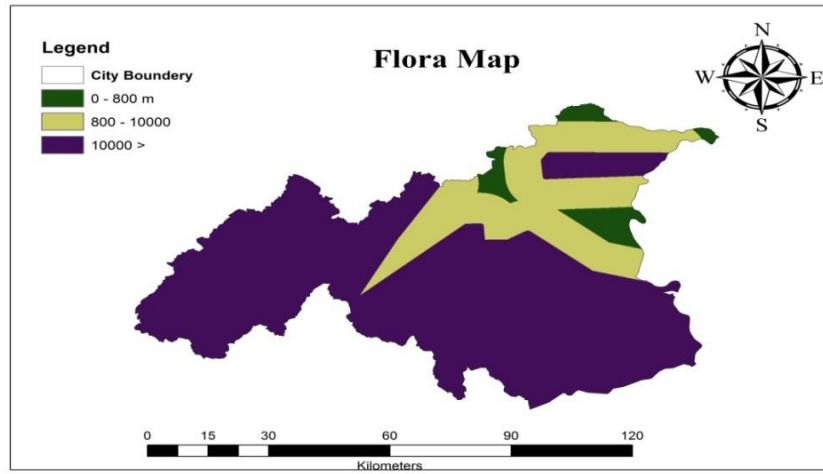


Figure 4.29 Flora map prepared by classification process in ArcGIS

Figure 4.29, according to the criteria specified in the ArcGIS software reclassification process prepared by the Gaziantep province vegetation data layer map is seen.

4.4.3.13 Elevation

The lowest point of Gaziantep has an elevation of 290 meters. Digital Elevation Model using the elevation map of Gaziantep province is been obtained for the study. In consideration of the elevation map, the GIS class values are given in 290-650 m 3 points, 650-1000 m 2 points and 1000m > 1 points respectively (Akıncı et al., 2015). Figure 4.30 shows the elevation map of Gaziantep province.

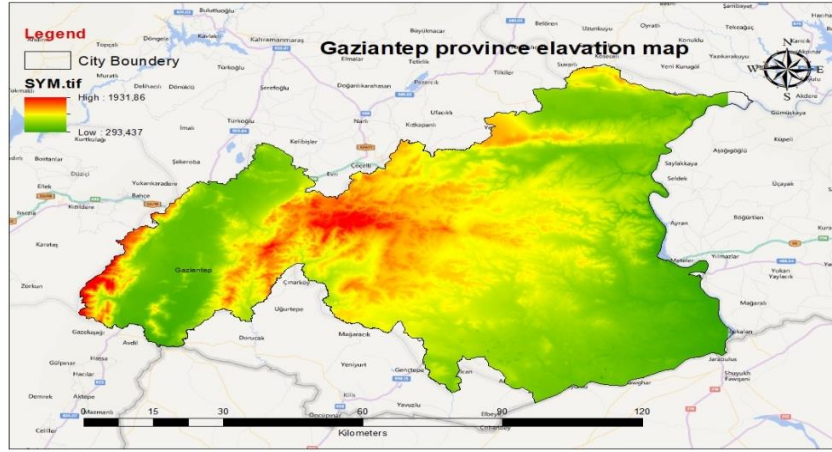


Figure 4.30 Gaziantep province elevation map

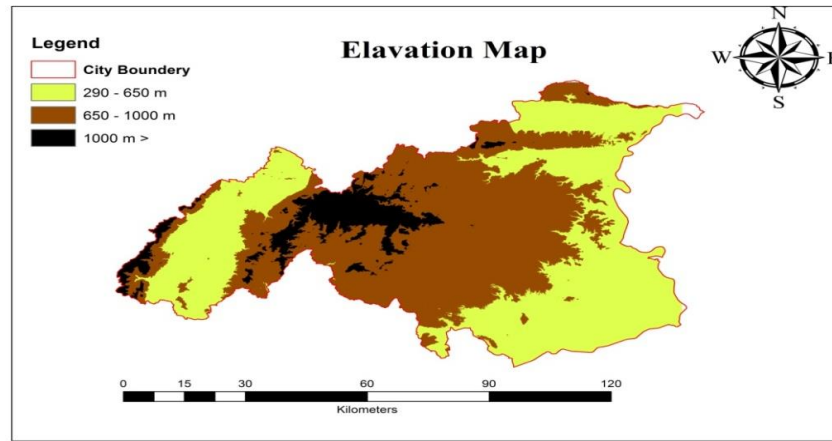


Figure 4.31 Flora map prepared by classification process in ArcGIS

In Figure 4.31, according to the criteria specified in the ArcGIS software reclassification process prepared by the Gaziantep province elevation data layer map is seen.

Table 4.4 shows the grading references of the previously selected site selection studies for the constraints determined for the criteria used in this study.

Table 4.4 Criteria for the study, acceptance criteria and source

No	Main Criteria	Sub-Criteria	Sub-Criteria Restriction Values	Source
1	C1. Location	C1.1. Settlement Distance (m)	1000-2000	(Güler, 2017)
			2000-3000	
			3000-5000	
		C1.2. Highway Distance (m)	50-1000	(Uyan, 2013)
			1000-3000	
			3000-5000	
		C1.3. Railways Distance (m)	0-3000	(Atıcı et al., 2015)
			3000-5000	
			5000-10000	
		C1.4. Airport Distance (m)	1000-3000	(Güler, 2017)
			3000-5000	
			5000>	
		C1.5. Distance to Border Crossings (m)	50000-75000	Expert opinions on site selection
			75000-100000	
			100000>	
2	C2. Disaster	C2.1. Proximity to Disaster Affected Population (m)	1000-5000	AFAD experts opinions
			5000-10000	
			10000>	
		C2.2. Distance to Fault Line (m)	18000-20000	(Sonmez, 2011)
			20000-40000	
			40000>	
		C2.3. Landslide Risk	0-80 (very low)	(Gaziantep AFAD, 2019a)
			80-160 (low)	
			160-240 (medium)	
3	C3. Land Structure	C3.1 Slope %	0-1	(Uyan, 2013)
			1-3	
			3>	
		C3.2. Flora (m)	0-800	Expert opinions on site selection
			800-10000	
			10000>	
		C3.3. Elevation (m)	290-650	(Akıncı et al., 2015)
			650-1000	
			1000>	

Priorities/ weights of all criteria were determined based on expert opinions' and studies in the literature since grade for each class and each of the criteria is classified within itself. Specific constraint values are determined for each sub-criterion. The selection process of the restriction values is described in detail in section 4.4.3.

Table 4.5 Main criteria sub-criteria restriction and GIS class values

No	Main Criteria	Sub-Criteria	Sub-Criteria Restriction Values	GIS Class Value (0-5)
1	C1. Location	C1.1. Settlement Distance (m)	1000-2000	3
			2000-3000	2
			3000-5000	1
		C1.2. Highway Distance (m)	50-1000	3
			1000-3000	2
			3000-5000	1
		C1.3. Railways Distance (m)	0-3000	5
			3000-5000	3
			5000-10000	1
		C1.4. Airport Distance (m)	1000-3000	5
			3000-5000	3
			5000 >	1
		C1.5. Distance to Border Crossings (m)	50000-75000	3
			75000-100000	2
			100000 >	1
2	C2. Disaster	C2.1. Proximity to Disaster Affected Population (m)	1000-5000	5
			5000-10000	3
			10000 >	1
		C2.2. Distance to Fault Line (m)	18000-20000	1
			20000-40000	3
			40000 >	1
		C2.3. Landslide Risk	0-80 (very low)	5
			80-160 (low)	3
			160-240 (medium)	1
3	C3. Land Structure	C3.1. Slope %	0-1	5
			1-3	3
			3 >	1
		C3.2. Flora (m)	0-800	1
			800-10000	2
			10000 >	3
		C3.3. Elevation (m)	290-650	3
			650-1000	2
			1000 >	1

The constraint values listed in Table 4.5 are used to create buffer zones around them and to limit areas unsuitable for disaster logistic warehouse.

4.4.3.14 Buffer Zones and Acceptances

A separate buffer zone is created for the map layers of all criteria through the Euclidean distance module in ArcGIS.

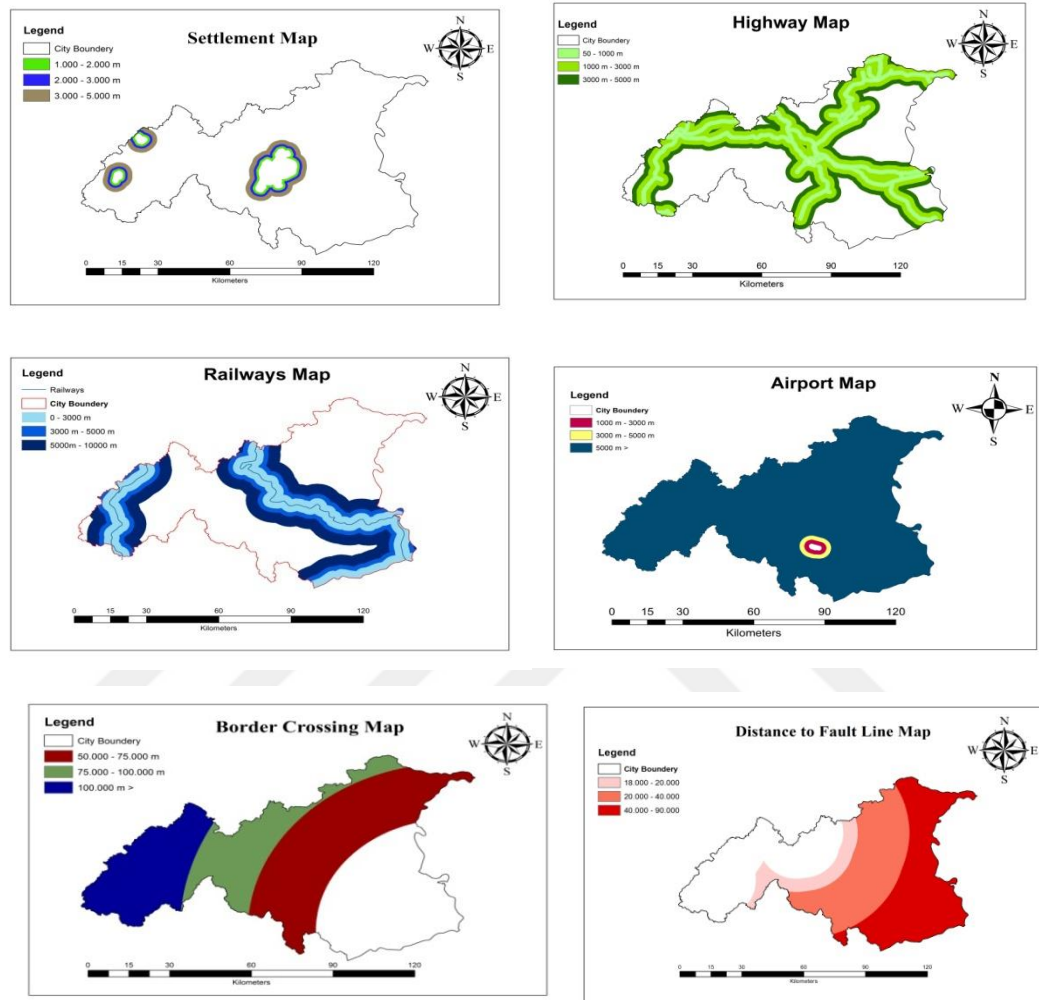


Figure 4.32 Euclidean Distance analysis for proximity to Settlement, Highway, Railways, Airport, Border Crossings and Fault Line criteria

Figure 4.32 shows the results of the Euclidean Distance analysis performed in ArcGIS software for 6 sub-criteria.

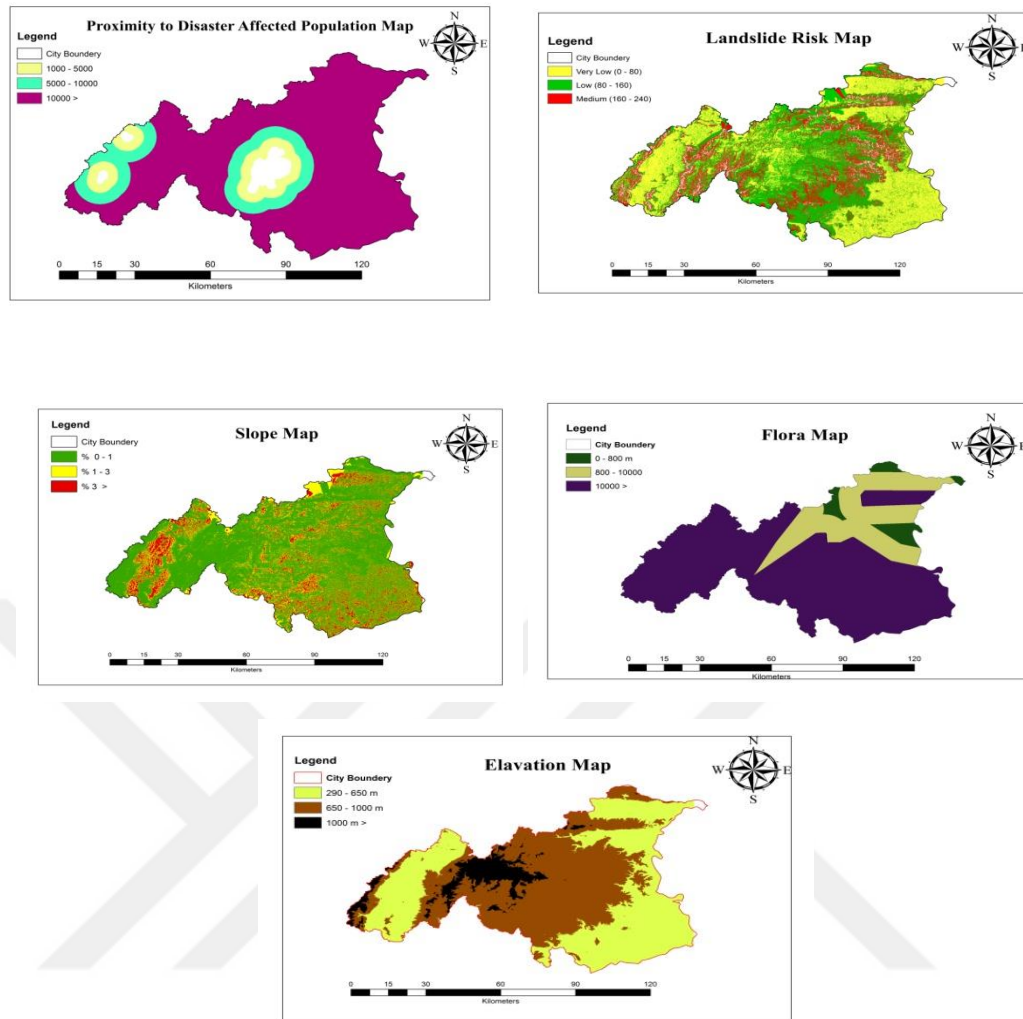


Figure 4.33 Euclidean Distance analysis for proximity to Disaster Affected Population, Landslide Risk, Slope, Flora and Elevation criteria

Figure 4.33 shows the results of the Euclidean Distance analysis performed in ArcGIS software for 5 sub-criteria.

4.4.4 Overlay Analysis

The first step in developing multi-criterion decision analysis in the GIS database is the standardization of the attributes of the criteria. Each criterion in the current data has its own attribute values and is different and incompatible with other criteria values.

The data related to the factors to be used were prepared while creating the model. Euclidean Distance calculation tool, which contains remote data, has been added to the model as the subcriterion. The data obtained from the work of the equipment was

linked to the reclassification process according to the criteria previously decided. The data created by the reclassification tool were overlapped by the weighted collection method. The weight of each factor was previously calculated by the AHP method (Figure 4.10). The values of the factors to be used have been determined to influence the analysis of the intervals. The specified weights have been merged with data previously held in the GIS environment. The data obtained as a result of the overlapping process is provided as input to the masking tool. The Model Builder function of the software is used for the study.

The most suitable areas for the installation of disaster logistics warehouse are determined by the trapping process which was weighed using the Model Builder module of the ArcGIS software. The results are found in raster data format with the help of GIS's positional analyses. The map containing the data obtained by running the generated model is shown in Figure 4.34.

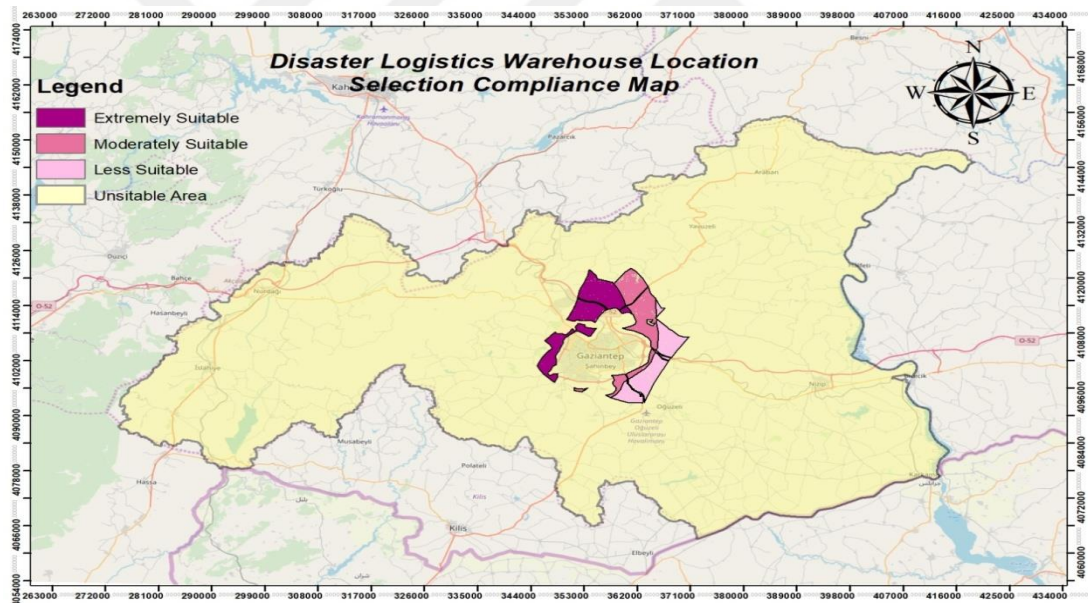


Figure 4.34 Disaster logistics warehouse installation site compliance map (1)

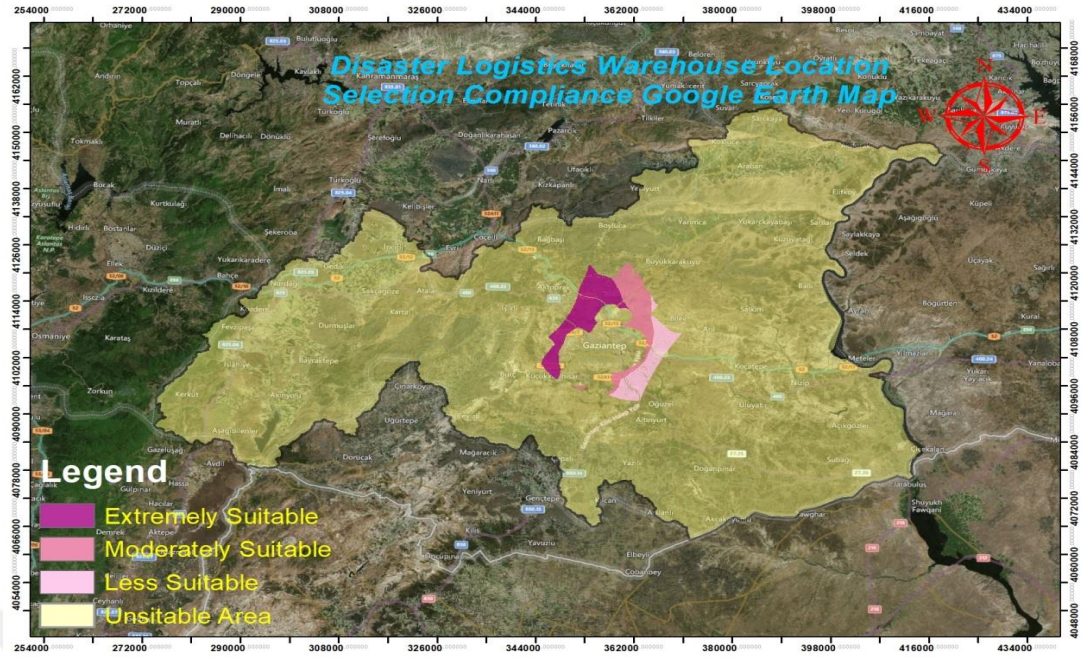


Figure 4.35 Disaster logistics warehouse installation site compliance map (2)

According to the conformity map formed as a result of the analysis (Figure 4.35), it is seen that the areas located on the northwest and southwest sides near Gaziantep settlement are very suitable, the areas on the northeast side are moderate and the areas on the southeast side are less suitable. Apart from these regions, the places within the study area do not seem suitable for the establishment of disaster logistics warehouse.

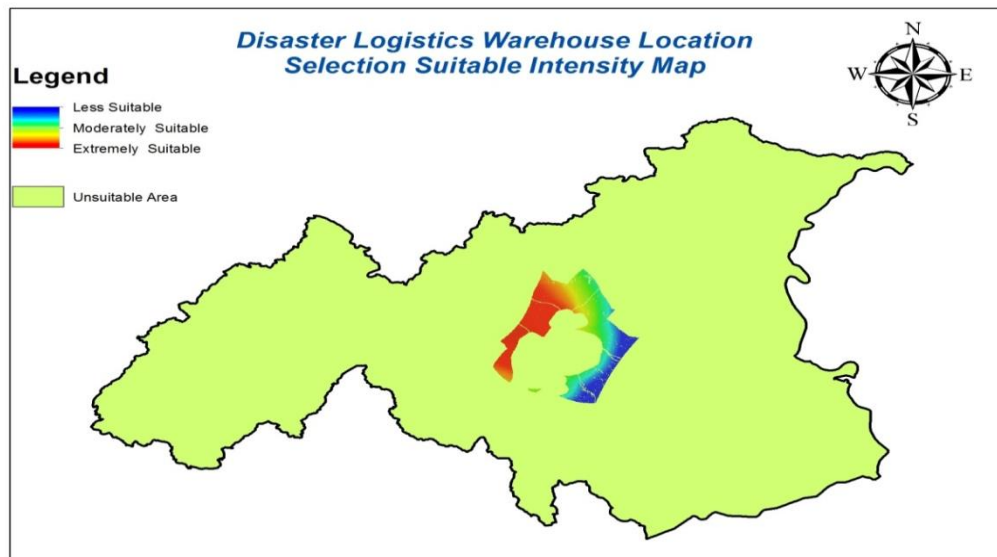


Figure 4.36 Disaster logistics warehouse installation area compliance intensity

Heat Map" (heat-density map) is produced from the conformity data obtained as shown in Figure 4.38. Considering the work area density of the resulting density map results, the areas from the heat-density map in ArcGIS software are grouped under four classes, as shown in Figure 4.36.



CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 Evaluation of Areas Identified in Result Analysis

The conformity map for areas where disaster logistics storage can be established in Gaziantep province are formed by combining the GIS and AHP method. The criteria selected according to the general characteristics of the study area are combined with the ArcGIS software using the weight values obtained by AHP and the areas suitable for disaster logistics warehouse installation are determined (Figure 5.1).

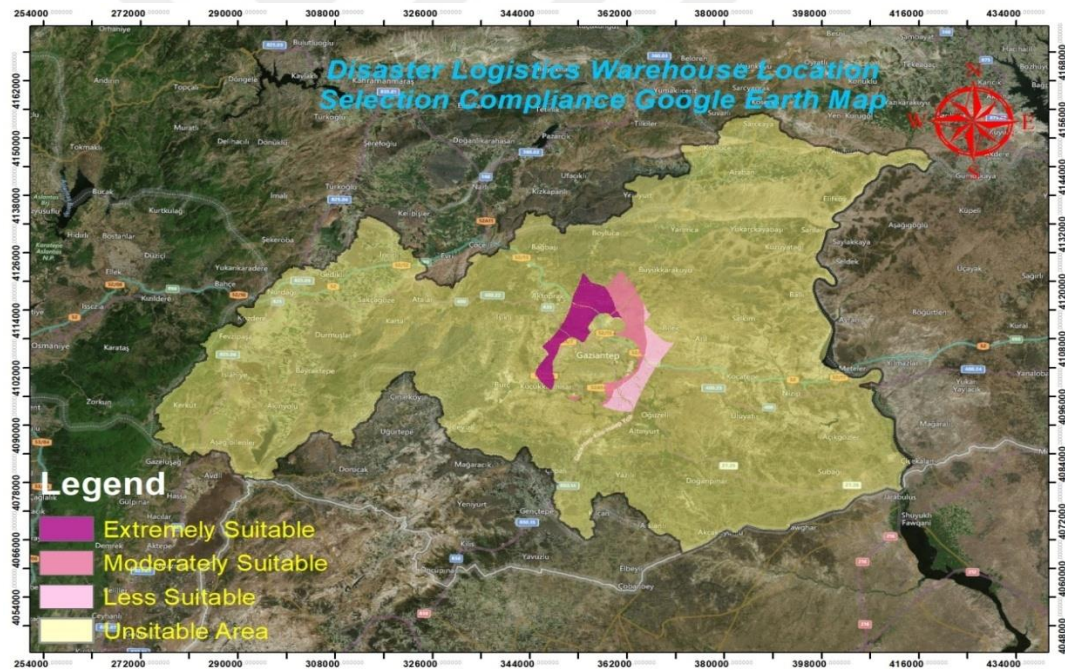


Figure 5.1 Disaster logistics warehouse installation site compliance

Fields obtained as a result of the conformity map analysis are divided into four categories as low suitable, moderately suitable, extremely suitable, and unsuitable areas. There are spatial information for classes created in Table 5.1.

Table 5.1 Spatial information of classes

Class	Area (km ²)	Percent (%)
Low suitable	68,15	1
Moderately suitable	79,12	1,16
Extremely suitable	88,41	1,3
Unsuitable	6.558,56	96,54

According to the results obtained, an area of 88, 41 km² of work area is quite suitable for the establishment of a disaster logistics warehouse. However, this value only covers part of the work area, such as **1.3%**. A portion of 1.16% of the work area is medium-suitable and 1% is low- suitable. 96.54% of the work area is strictly not suitable for the establishment of disaster logistics warehouse. The reason of inappropriate fields being so high stems from the assigned GIS limitation and class values for the criteria that used in the study.

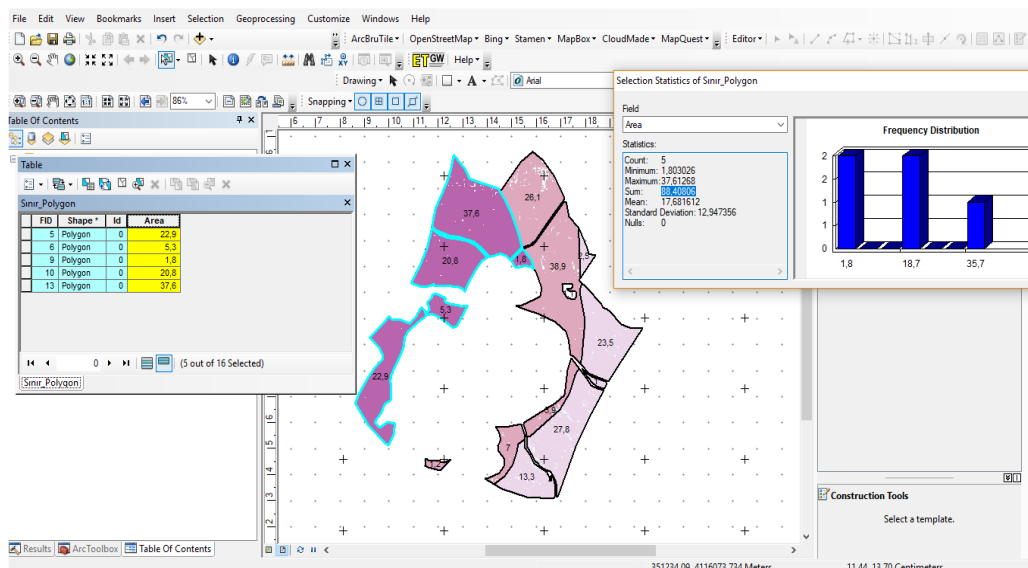


Figure 5.2 Calculation of extremely suitable areas in ArcGIS software

Figure 5.2 shows how the appropriate areas detected in the ArcGIS software are calculated as m².

The existing AFAD logistics warehouses are built on an area of 10,000 m² and have a covered area of 2,400 m². There are no land cost criteria in this study, since there is no opportunity to reach sufficient data about land cost in this study area. The land cost was analysed based on the results obtained (Table 5.1), by the help of AYDES (Disaster Management Decision Support Systems) program within the most suitable 88.41 km² working area where disaster logistics warehouse will be established. While analysing the land cost by the AYDES program, public land and private lands are separated over minimum 10,000 m² areas required for the establishment of disaster logistics warehouse.

Considering the existing AFAD logistics warehouse areas the 3 regions selected from among the extremely suitable areas identified are described below with their locations.

Area 1; Gaziantep Sehitkamil district is located within the boundaries of Baspinar organized industrial zone, 50 m away from Adana-Sanlıurfa highway. In the inquiry made in the land registry and cadastre information system, the area in question belongs to the treasure, is located on 0 block and 33 plot and has a size of 972,210 m². Figure 5.3 shows the title deed information system image.



Area 2; It is located in Sehitkamil town Yalangoz district 6 km away from Adana-Sanlıurfa highway and 50 m away from the northern city public housing project road constructed by Gaziantep Metropolitan Municipality. In the interrogation made in the land registry and cadastre information system, the area in question belongs to the treasure, is located on 110 block and 33 plot and has a size of 42,074 m². Figure 5.4 shows the title deed information system image.



Figure 5.4 The second most appropriate area where disaster logistics warehouse will be established

Area 3; Sehitkamil town Buyuk Pinar district is 400 m away from the ring road. In questioning in the land registry and cadastre information system, the area in question is private land, it is located on 0 block and 991 plot and has a size of 47,720 m². Figure 5.5 shows the title deed information system image.

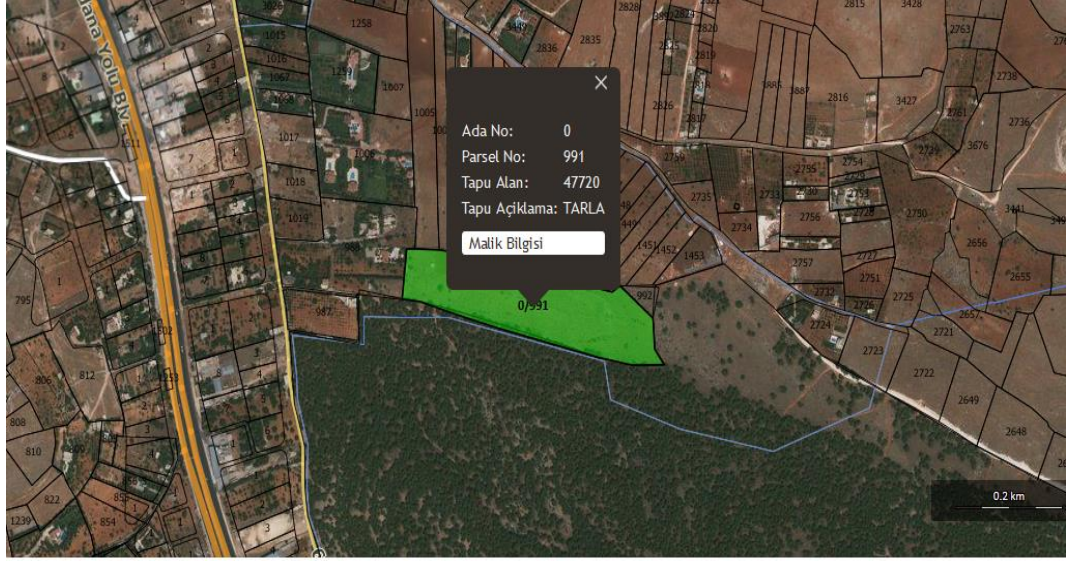


Figure 5.5 The third most appropriate area where disaster logistics warehouse will be established

As a result of the evaluations, considering the sub-criteria and location, disaster and the structure of the land, area 1 is selected among the most suitable 3 areas in Figures 5.3, 5.4, 5.5. for following reasons:

- Sufficient distance to the settlement,
- Being very close to the highway and railway,
- Complies with potential disasters and the distance restriction distances specified for operation to the fault line,
- Meet slope, elevation and flora criteria,
- Being located in the organized industrial zone and all the infrastructure (electricity, drinking water, sewage, etc.) is present,
- The land belongs to the treasury (reducing installation cost).

After field 1, the field 2 may be considered as an alternative. The reason for this is that the area 2 is close to the highway, it complies with the potential disasters and the distance restriction distances determined for the study, complies with the inclination, elevation and slope criteria, the infrastructure is available and it belongs to the treasury. Subsequent to the field 2, the field 3 can be considered as an alternative field. The reason for considering area 3 as the last alternative area was due to the fact that it is very close to the settlement area and it is private land.

5.2 Analysis of Results and Investigation of the Model

The scope of the disaster logistics warehouse area is carried out in the context of establishing model for the selection process. GIS-based MCDM methods are an important decision support mechanism for location selection studies in the making of fast and optimal decisions. The most important issue affecting the outcome, no matter how strong the methods, is to accurately determine the criteria that impact the event. The results can be assessed as accurately as the criteria that are often assessed with expert opinions and possible to reveal incorrect results due to subjective judgments.

There are many site selection studies in the literature, with the integration of MCDM methods and GIS systems. In these studies, many criteria have been defined that influence the selection of the site. This is because the work areas show different characteristics in terms of topographic, climate, geological, transportation, etc. The data, weights and parameters to be used as inputs according to the properties of the working area can be modified. The criteria should be assessed by experts on the subject in the study of location selection in GIS-based MCDM methods. Because the sensitivity of the input data has a direct effect on the result. The criteria used in this study were evaluated by experts working in AFAD, who have been involved in the selection of the site. The results of the study were examined by these specialists and confirmed the reliability of the designated areas.

The criteria and weights used for location selection of disaster logistics warehouse area can vary according to the working area and preferred severity. Scenarios with location, disaster or structure of terrain can be produced. It will facilitate the implementation of these processes with a dynamic model that can be modified and minimize any errors that may arise during the processing of the data.

“The Builder Model” module is the visual programming tool of ArcGIS. Through this tool, all the steps are given to the process flowcharts can be connected one after another on the Model Builder screen, and the inputs and outputs can be checked and converted into a way that can perform all the steps in a single moment. The "**Model Builder**" module in the ArcGIS software used in the study was created for the storage field. The model is prepared according to the data used in the study. In different studies, the selection process can be performed with different criteria using the same model.

5.3 Scenario Analysis

In this study, using the AHP, one of the MCDM methods, the criteria affecting the selection of the location of the disaster logistic storage area are compared according to their importance levels and their importance weights are determined. In the our study the weights calculated for the weighted registration process are shown in Figure 4.6. According to the results of AHP method, the main criterion for the location was calculated as 0.31, the disaster was 0.58 and the structure of the land was calculated as 0.11. These weights were determined as a result of the pairwise comparison matrix prepared in line with the opinions of the experts working at AFAD were changed in order to examine the model and the results were evaluated. The new scenario in the AHP method has been created by keeping the location criterion more important (Figure 5.6). In the scenario created by keeping the location main criterion important, the location main criterion in the AHP results was calculated as 0.73, disaster and 0,19, and the structure of the land as 0.8, and the weights of the sub-criteria were also recalculated.

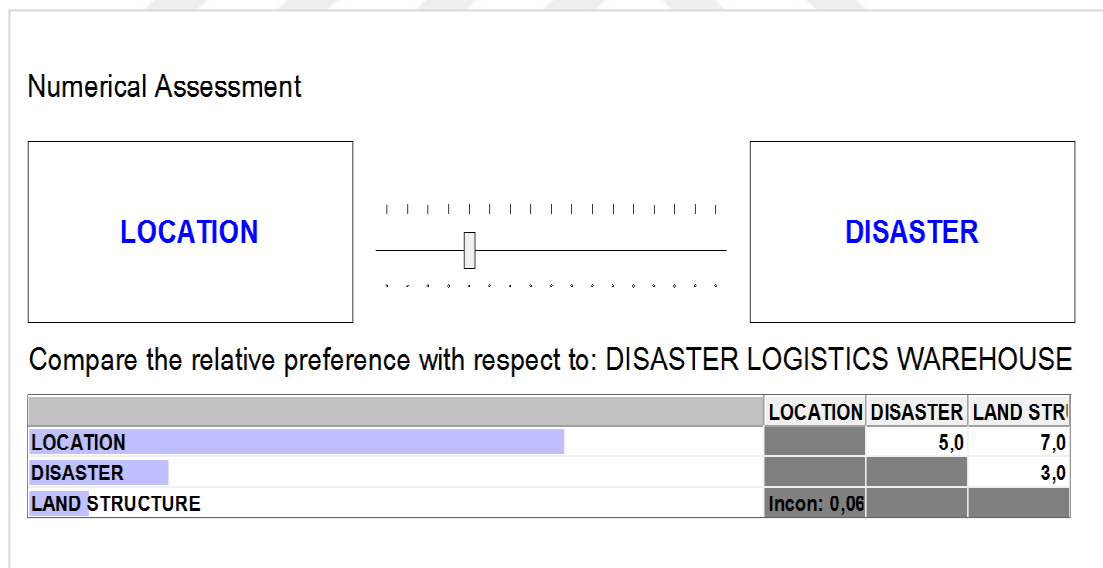


Figure 5.6 Matrix of the main criteria in the scenario study

Figure 5.7 and Figure 5.8 show the weights of the main and sub-criteria calculated according to the scenario.

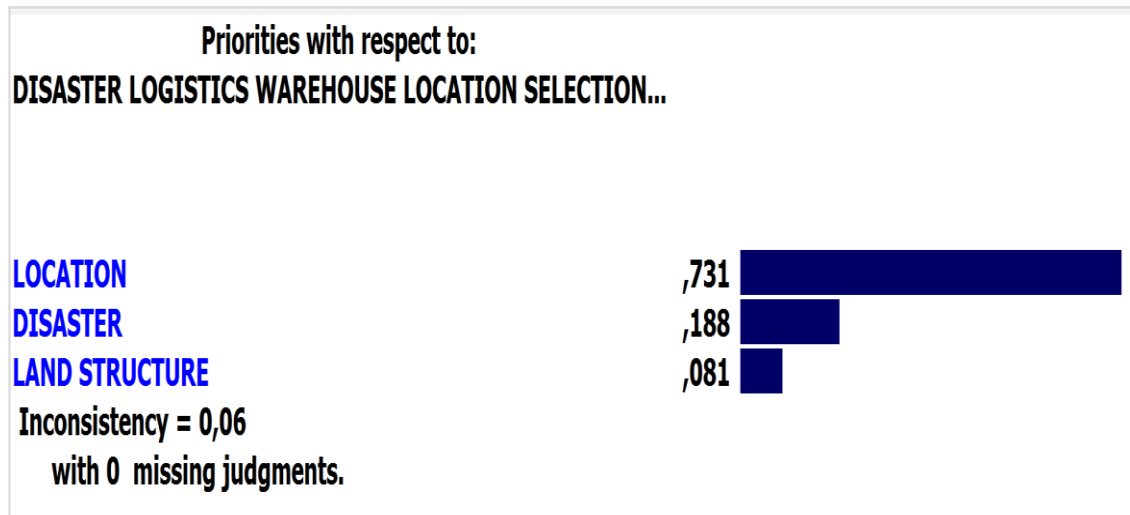


Figure 5.7 Weights of the main criteria calculated in the scenario study

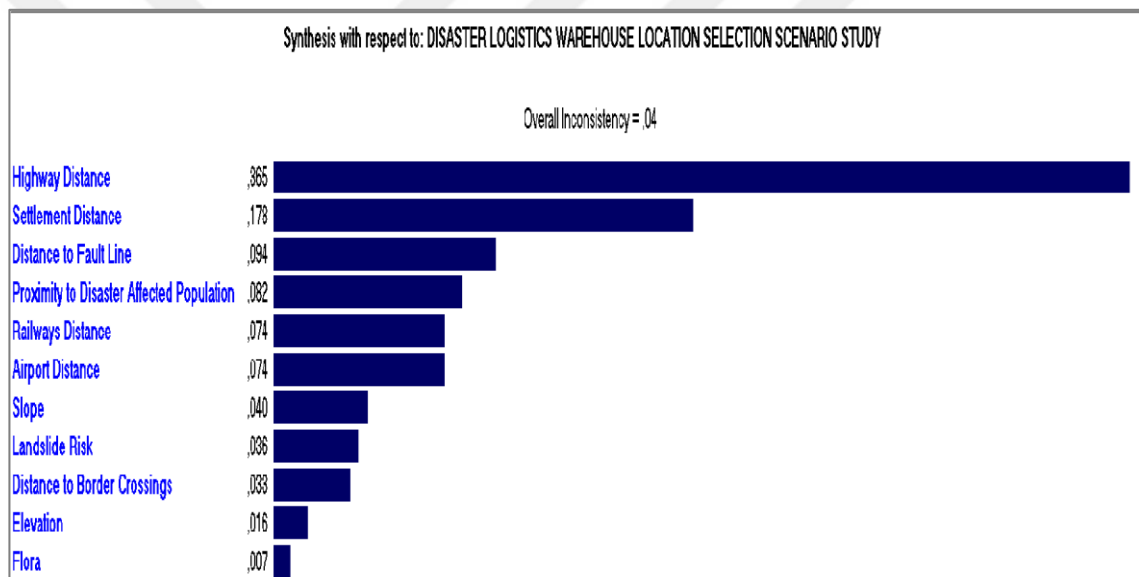


Figure 5.8 Weights of the sub-criteria calculated in the scenario study

The model is run by recalculating weights and the result data for the scenario is obtained.

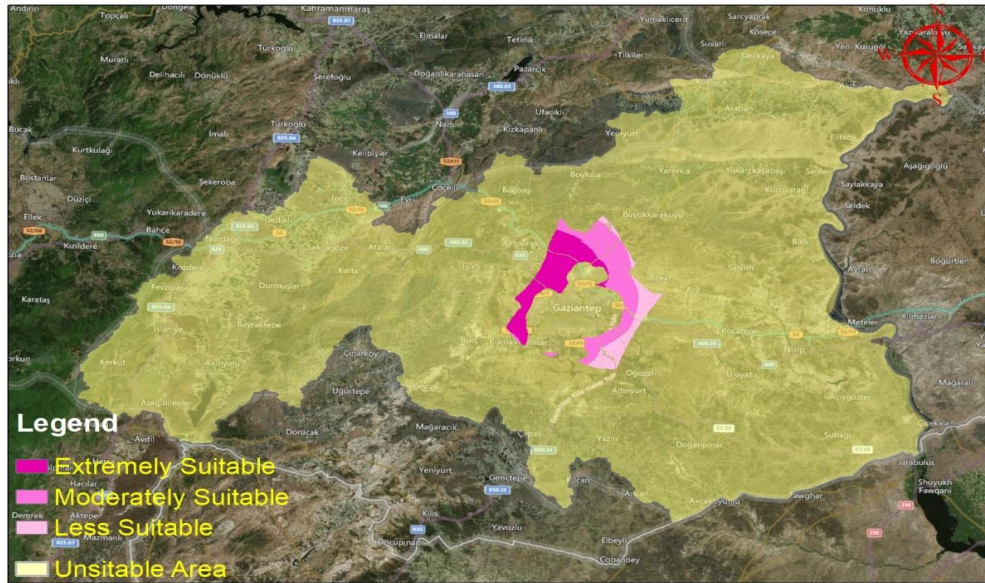


Figure 5.9 Disaster logistics warehouse scenario compliance map

Table 5.2 Spatial information of the classes according to the results obtained in the scenario study

Class	Area (km ²)	Percent (%)
Low suitable	50,34	0,75
Moderately suitable	105,84	1,56
Extremely suitable	81,21	1,19
Unsuitable	6.556,85	96,5

When the result suitability map in Figure 5.9 is examined in Table 5.2, the areas of “Extremely suitable” class decreased by 0.11%, while the areas of “Moderately suitable” class increased 0.4%. On the other hand, the areas of "Less suitable " class decreased 0.25% and "Unsuitable” class 0.04% decreased. This study has found that different results are achieved in site selection with the weights determined in the scenario study. In this study, as a result of the pairwise comparisons of the criteria prepared according to the opinions of the experts working in AFAD, when the ArcGIS result suitability map was evaluated, it was seen that the pairwise comparison table created for the criteria was consistently determined. In addition, it was seen that the model used can be used in different studies with different criteria weights.

CHAPTER 6

CONCLUSION AND SUGGESTIONS

The aim of the study was to develop a location selection method that uses the Analytical Hierarchy Method (AHP) with the Geographic Information System (GIS) support for the disaster logistics storage area in Gaziantep province. In this study, the location criteria of disaster logistics warehouse were determined based on the opinions of AFAD experts taking into account the characteristics of the region from the literature studies. In the Expert Choice program, the sub-criteria of the factors are graded in a standard way, and the weights calculated with the AHP method are calculated by the result weights used in the study of all criteria. In order to take more advantage of the effective analysis, the capacity of the GIS model is created so as to provide faster and more accurate results. Result data is obtained by running the generated model with the data layers used as input. The resulting data were classified according to the disaster logistics warehouse area and the result map was created. As a candidate, the regions selected and evaluated as a result of alternative most appropriate disaster logistics warehouse areas were proposed.

According to the results obtained in the study, an area of 88,41 km² of work area is quite suitable for the establishment of a disaster logistics warehouse. However, this value only covers part of the work area, such as 1.3%. A portion of 1.16% of the workarea is medium-suitability and 1% is low-fidelity. 96.54% of the work area is strictly not suitable for the establishment of disaster logistics warehouse. As it is mentioned at the chapter 5.1, the reason of inappropriate fields being so high stems from the assigned GIS limitation and class values for the criteria that used in the study.

As a result of the evaluations, considering the sub-criteria and location, disaster and the structure of the land, Gaziantep Sehitkamil district, within the boundaries of Baspinar Organized Industrial Zone, Adana-Sanlıurfa 50 meters away from the 0 block and 33 parcels on the area of 972,210 m² size has been identified as the most appropriate area for the establishment of disaster logistics warehouse. According

to the results of this study, the chosen area is in line with the expectations of the decision makers and supports their decisions.

In addition to determining criterion weights, sensitivity analysis was performed in GIS environment by keeping the location criterion important to test the sensitivity of the model and verify the model. When the data obtained as a result of sensitivity is examined in the findings and analyzes, it is seen that “Extremely suitable ” areas decreased by 0.11% while "moderate suitable "areas increased by 0.4%. On the other hand, “less suitable ” areas decreased by 0.25% and "unsuitable ” areas decreased by 0.04%. It was observed that it has been found that different results were achieved in site selection with the weights determined in the scenario study. In this study, conducted for disaster logistics warehouse location selection, it was seen that high accuracy results can be obtained when GIS and AHP method is used together. Furthermore, it was seen that the criteria weights of the selected criteria and the restriction values determined for the criteria in GIS analysis were determined accurately and consistently. It was also observed that the model used in the studies carried out in different works with different criteria weights.

The criteria determined in this study and the weighting process based on these criteria were established for disaster logistics warehouse location selection. Site selection models are application-specific problems and their variables/criteria vary according to the problem being studied. The study can be extended to the location of disaster logistics warehouses that can be established by AFAD, Red Crescent and NGOs.

When GIS, AHP and site selection literature were searched, no study using GIS and AHP together in disaster logistics warehouse location selection was found. This study is expected to contribute on the literature disaster management for Turkey and it will solve a real problem also.

With the effective and efficient implementation of disaster logistics, rapid and accurate intervention to the disaster areas can be achieved in a short time with much more people in need. Therefore, possible casualties in the disaster areas can be minimized. On the other hand, the right logistic strategies to be developed during the reconstruction and improvement phase will contribute to the socio-economic

development of regions that are torn for the crisis, such as war, conflict, drought, hunger and poverty. With the focus of this kind of work, it is assessed that Turkey will make great contributions to prevent damages and losses in future disasters.

It is seen from the results of the sensitive analysis that it is very important to determine the weights accurately, reliably and scientifically. Since the determination of criterion weights is an important action in disaster management, criterion weights can be determined together with theoreticians and decision-makers as a suggestion in this case. The results obtained by using GIS together with another MCDM method can be compared to different from the MCDM's AHP method in future studies. In addition, due to the sensitivity of GIS restriction values and class values for the criteria determined in similar studies directly affects the result, it is considered that it would be beneficial to apply the views of more experts of the subject in the site selection studies related to giving these values in GIS.

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APPENDICES

Figure A.1 Main criteria paired comparison results

Figure A.2 Disaster sub-criteria paired comparison results

Figure A.3 Main location sub-criteria paired comparison results

Figure A.4 Land structure sub-criteria paired comparison results

Figure A.5 Graphical representation of matrix created for main-criteria

Figure A.6 Graphical representation of matrix created for disaster

Figure A.7 Graphical representation of matrix created for land structure

Figure A.8 Graphical representation main criteria performance sensitivity

Figure A.9 Weighted head to head between settlement and highway distance

Figure A.10 Calculation of low suitable areas in arcgis screenshot

Figure A.11 Calculation of moderately suitable areas in arcgis screenshot

Questionnaire

File Edit Assessment Go Help

Compare the relative importance

LOCATION versus **DISASTER**

with respect to: DISASTER LOGISTICS WAREHOUSE SELECTION

1 LOCATION	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	DISASTER
2 LOCATION	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	LAND STRUCTURE
3 DISASTER	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	LAND STRUCTURE

1 = Equal 3 = Moderate 5 = Strong 7 = Very Strong 9 = Extreme

Figure A.1 Main criteria paired comparison results

Questionnaire

File Edit Assessment Go Help

Compare the relative importance

PROXIMITY TO DISASTER AFFECTED POPULATION

versus

DISTANCE TO FAULT LINE

with respect to: DISASTER (L: ,582)

1 Proximity to Disaster Affected Population	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Distance to Fault Line
2 Proximity to Disaster Affected Population	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Landslide Risk
3 Distance to Fault Line	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Landslide Risk

1 = Equal
3 = Moderate
5 = Strong
7 = Very Strong
9 = Extreme

Figure A.2 Disaster sub-criteria paired comparison results

Questionnaire

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Compare the relative importance

SETTLEMENT DISTANCE versus **HIGHWAY DISTANCE**

with respect to: **LOCATION (L: ,309)**

1 Settlement Distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9 Highway Distance
2 Settlement Distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9 Railways Distance
3 Settlement Distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9 Airport Distance
4 Settlement Distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9 Distance to Border Crossings
5 Highway Distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9 Railways Distance
6 Highway Distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9 Airport Distance
7 Highway Distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9 Distance to Border Crossings
8 Railways Distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9 Airport Distance
9 Railways Distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9 Distance to Border Crossings
10 Airport Distance	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9 Distance to Border Crossings

1 = Equal 3 = Moderate 5 = Strong 7 = Very Strong 9 = Extreme

Figure A.3 Main location sub-criteria paired comparison results

Questionnaire

File Edit Assessment Go Help

Compare the relative preference

SLOPE

versus

FLORA

with respect to: LAND STRUCTURE (L: ,109)

1 Slope	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Flora
2 Slope	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Elevation
3 Flora	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Elevation

1 = Equal

3 = Moderate

5 = Strong

7 = Very Strong

9 = Extreme

Figure A.4 Land structure sub-criteria paired comparison results

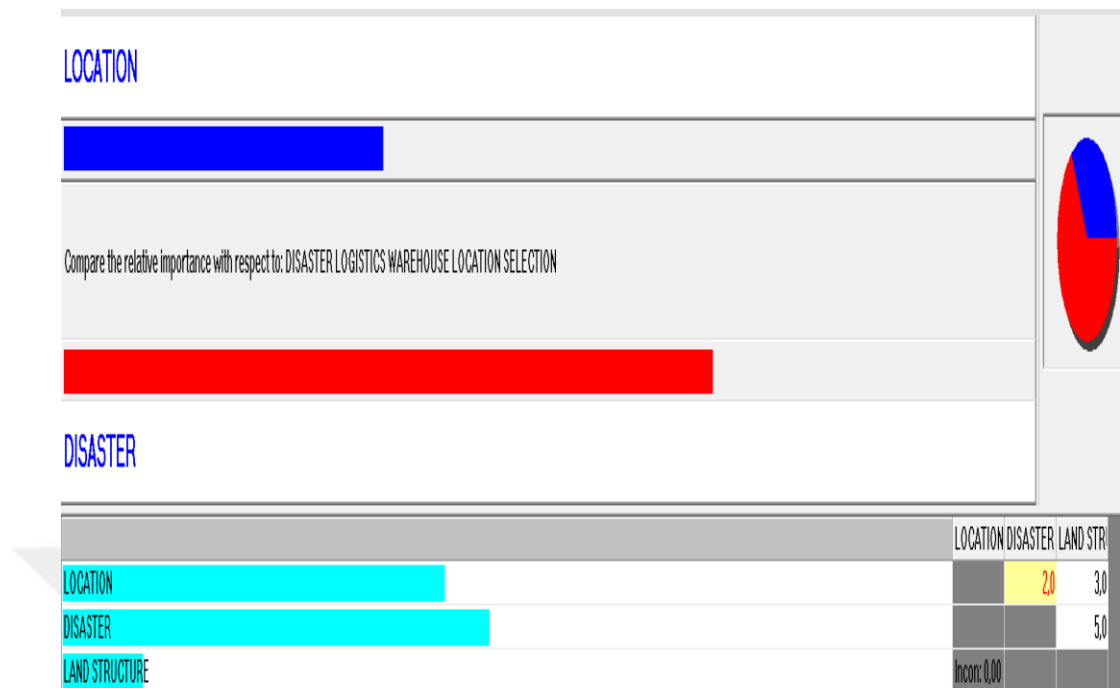


Figure A.5 Graphical representation of matrix created for main-criteria

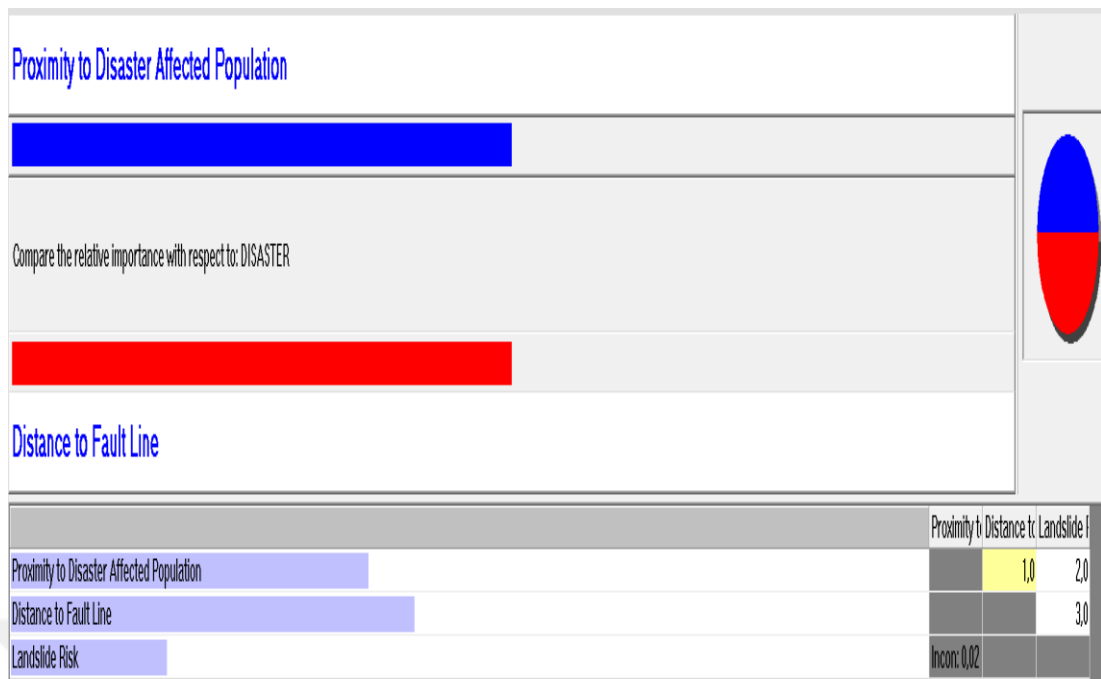


Figure A.6 Graphical representation of matrix created for disaster

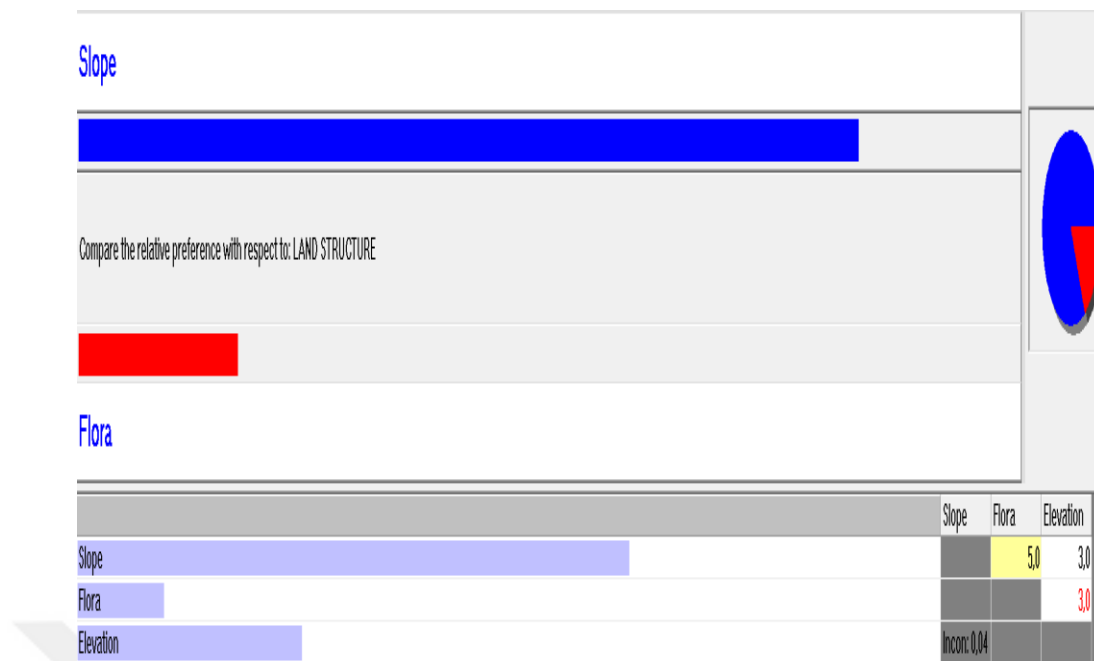


Figure A.7 Graphical representation of matrix created for land structure

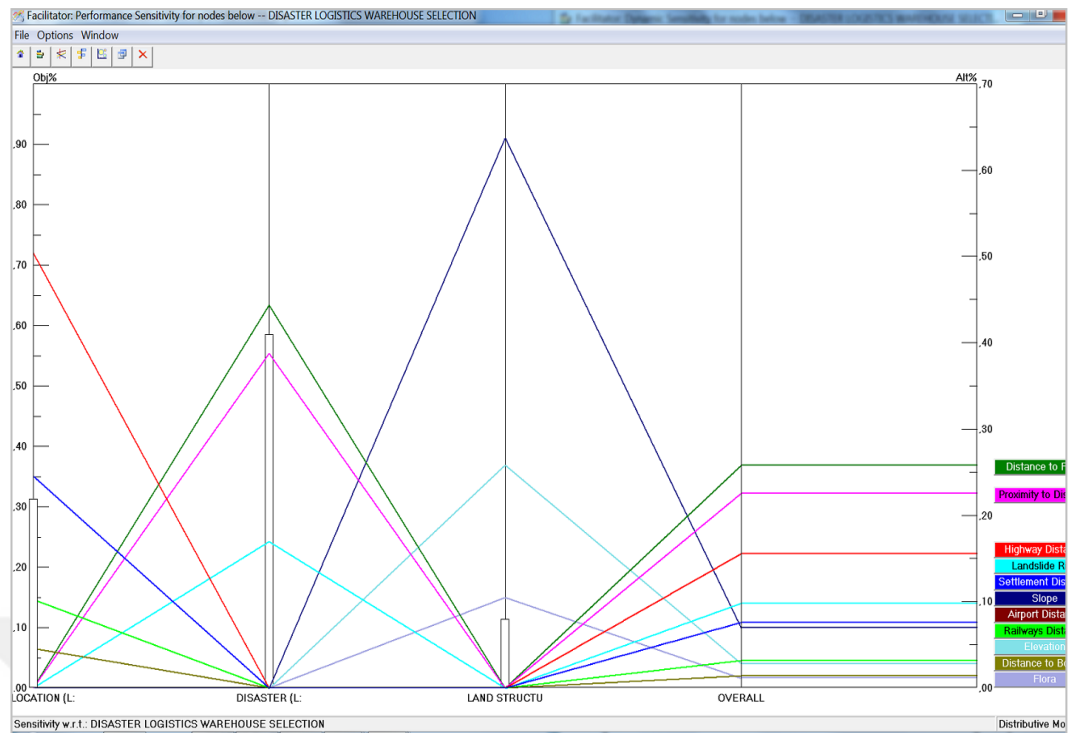


Figure A.8 Graphical representation main criteria performance sensitivity

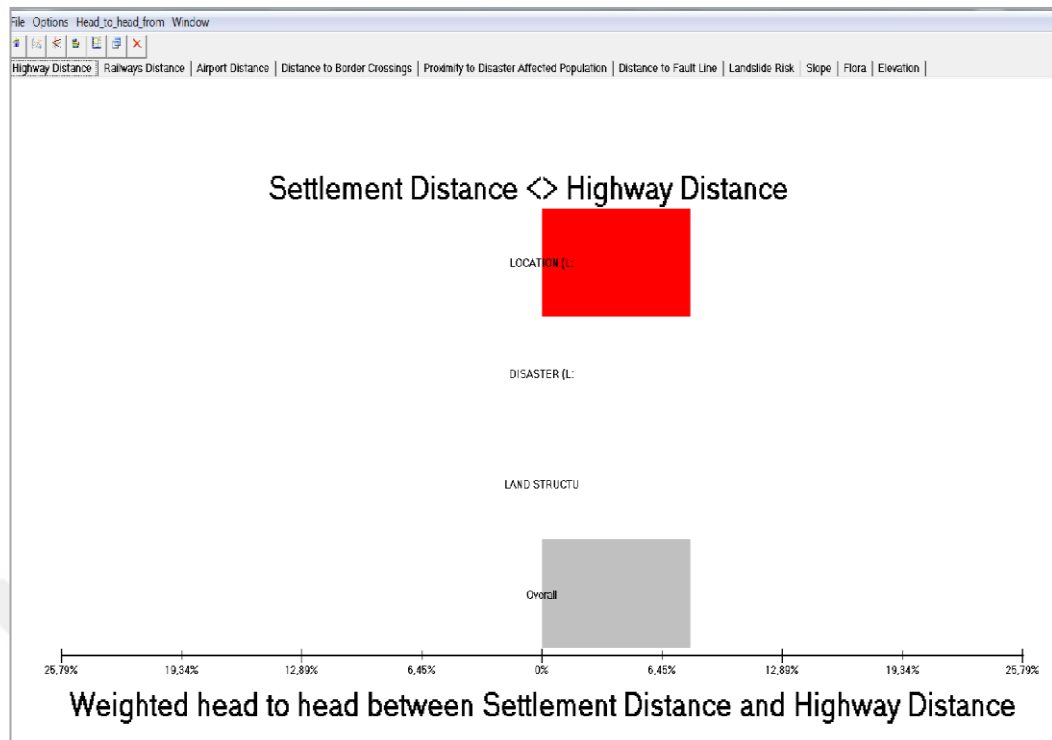


Figure A.9 Weighted head to head between settlement and highway distance

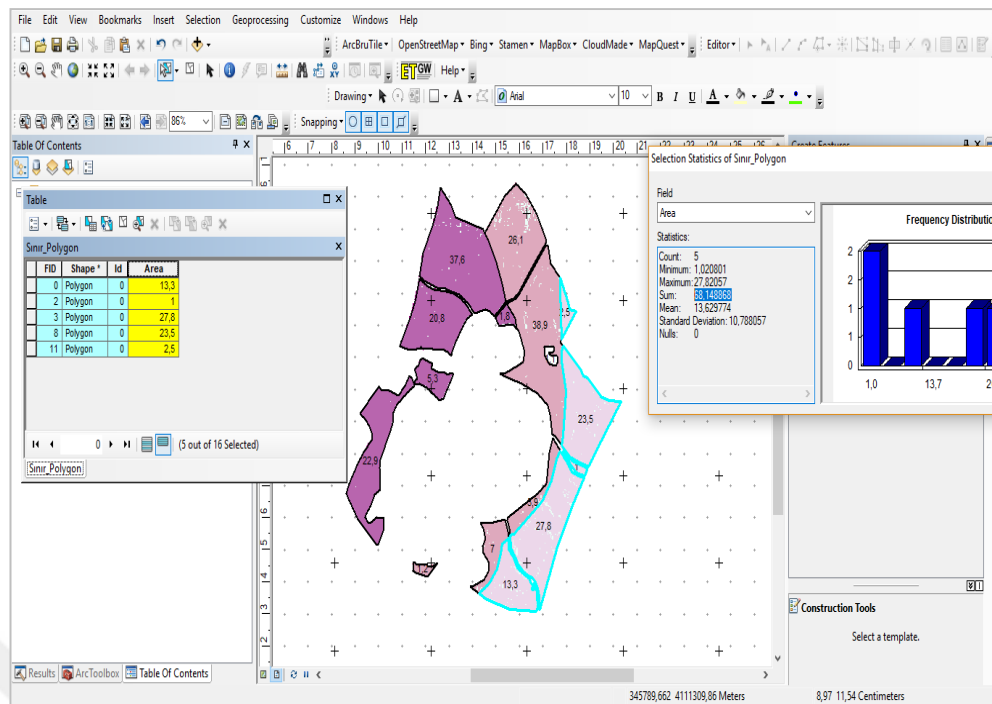


Figure A.10 Calculation of low suitable areas in arcgis screenshot

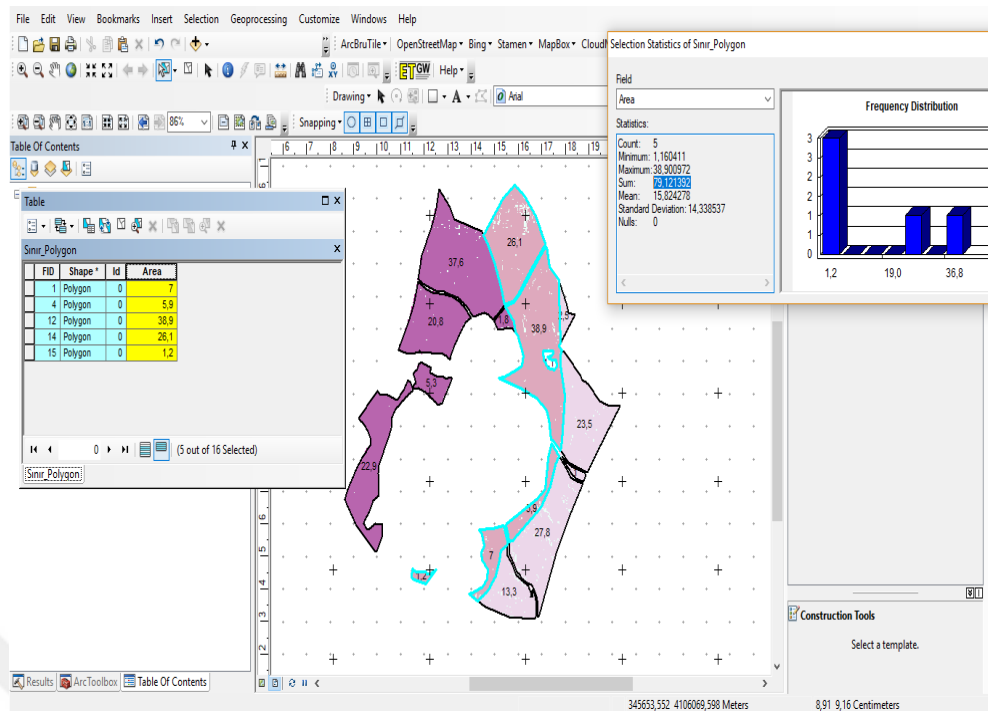


Figure A.11 Calculation of moderately suitable areas in arcgis screenshot