Advanced Land Management

https://publish.mersin.edu.tr/index.php/alm

e-ISSN 2822-7050

Assessment of the post-disaster assembly areas in the Merkez District of Uşak Province in Turkey

Fatma Yüksel Doğruyol [*1], **Fatih Taktak** [2]

[1] *Uşak University, Institute of Graduate Education, Department of Urban Transformation, Uşak, Türkiye, yukself2006@gmail.com*
[2] *Uşak University, Faculty of Engineering, Department of Surveying Engineering, Uşak, Türkiye, fatih.taktak@usak.edu.tr*

Cite this study: Doğruyol, F. Y., & Taktak, F. (2022). Assessment of the post-disaster assembly areas in the Merkez District of Uşak Province in Turkey. Advanced Land Management, 2 (1), 1-12

Keywords
Disaster
Post-Disaster
GIS
Disaster Response
Planning

Research Article
Received: 25.01.2022
Revised: 17.05.2022
Accepted: 23.05.2022
Published:30.06.2022

Abstract

Natural disasters, especially earthquakes are frequent in Turkey. After the 1999 Marmara earthquake and the 2011 Van earthquake, extensive studies were carried out on what should be done before, during, and after an earthquake. In late September 2019, earthquakes in Istanbul have raised the topic of post-disaster assembly areas and temporary shelters. One of the main subjects about these areas was whether they were in good condition or not. Within the scope of this study, post-disaster assembly areas in the Merkez district of the Uşak province in Turkey, criteria for determining these areas, their sizes, and compliance conditions with the specified standards would be evaluated. Besides, the distribution of the areas would be evaluated and the maps prepared using Geographical Information Systems (GIS). This study indicates that the assembly areas in Merkez and Uşak are not sufficient, especially in the populous neighborhoods, nearly half of the neighborhoods do not have any assembly areas, and many of them have infrastructure problems. The distribution is also another problem in different neighborhoods for different reasons. The analysis made through the GIS showed that the distribution is not homogenous in terms of accessibility, all areas in the district are located in central neighborhoods.

1. Introduction

Natural disasters are frequently occurring in our country. That's why it is necessary to have plans and guidelines for what both the public and the institutions, organizations, and response teams will do. In this context, action plans and disaster response plans are evaluated as informative and guiding documents [1-5].

So, the current Earthquake Strategy and Action Plan of the Uşak province, where the study area is located, was reached through the Provincial Disaster and Emergency Directorate (AFAD). According to the 2012-2023 Uşak Earthquake Strategy and Action Plan prepared in 2012, Uşak province has not been exposed to any large earthquakes, taking into account the historical periods. In the same manner, Uşak was also not affected by the large earthquakes occurring in the surrounding provinces [6-7].

Turkey's Earthquake Regions Map, which was entered into force in 1996, was updated by AFAD in 2018 and entered into force on January 1, 2019 under the name "Earthquake Hazard Map of Turkey." In Figure 1, the Earthquake Hazard Map of Turkey was adapted and the condition of Uşak province was indicated. According to the information from Turkey's Earthquake Regions Map, Uşak province was located in the second-degree earthquake zone, except for the Eşme district. On the other hand, the Eşme district was located in the first-degree earthquake zone.

On the Earthquake Hazard Map of Turkey, more detailed data is used instead of this degree system, and the concept of an earthquake zone is no longer used. The new map is prepared with much more detailed data, taking into account the most recent earthquake source parameters, earthquake catalogs and new generation mathematical methods. Unlike the previous map, the new map shows the peak ground acceleration values rather than earthquake zones and replaces the "earthquake zone" concept [8].

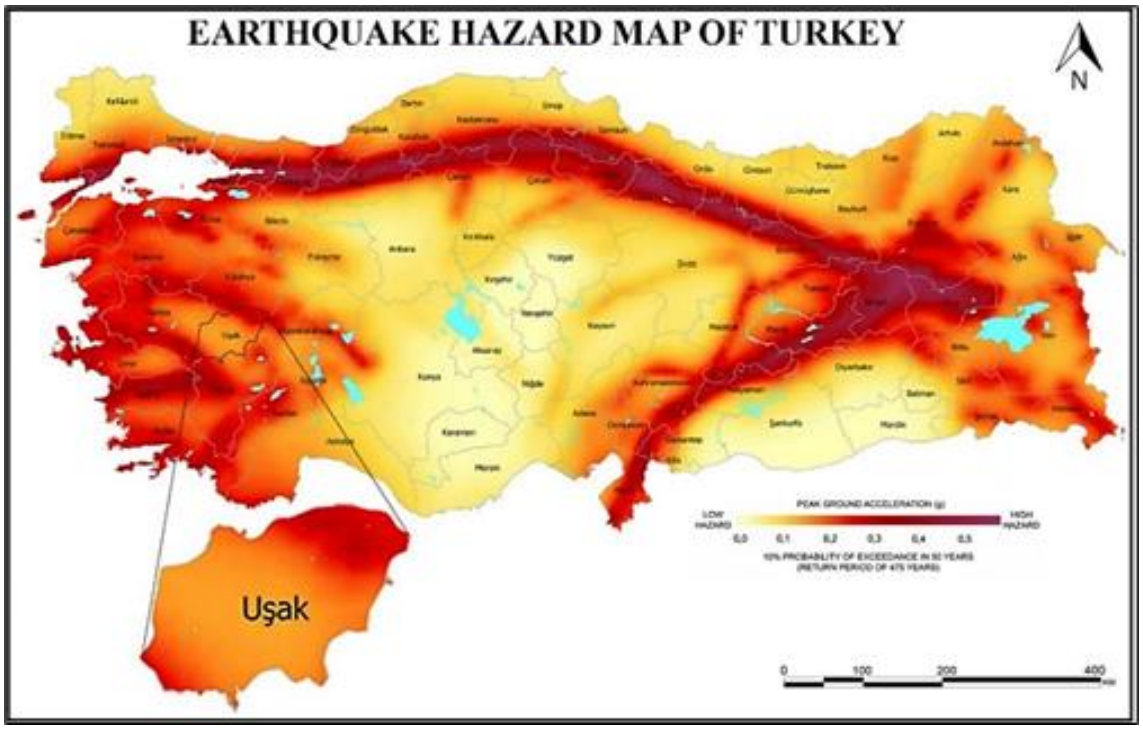

Figure 1. Earthquake Hazard Map of Turkey and the Condition of Uşak Province (Adapted from the Earthquake Hazard Map of Turkey) [8].

2. Post-Disaster Assembly Areas

The post-disaster assembly areas are also called primary evacuation areas and are defined by AFAD as follows: "Assembly areas are safe areas where people can gather by moving away from the dangerous area in the period following disasters and emergencies to prevent panic and provide a healthy exchange of information until the temporary housing centers are ready." [9-10].

The locations of the areas are determined by the relevant municipalities in each province, and AFAD indicates that seven criteria are taken into account when determining these areas. These criteria are as follows:

- Population density of the region,
- Access to the area and ease of evacuation
- Whether the area is accessible to the disabled and the elderly or not,
- Distance to secondary hazards,
- There should be availability in as many plain areas as possible.
- Availability near residential areas, not affected by structural/non-structural elements,
- Being situated near the infrastructure elements to respond to basic needs is important. The determined areas could also be accessed via e-Government.

Such criteria have been included in many national and international research and studies. For example, "The Study on A Disaster Prevention/Mitigation Basic Plan in Istanbul, including Seismic Microzonation in the Republic of Turkey" final report was prepared by the Istanbul Metropolitan Municipality (IMM) and the Japan International Cooperation Agency (JICA) in 2002 [11]. In this report, under the title of "Parks and Open Space Availability for Primary Safety Evacuation of Residents," a new urban disaster emergency evacuation system is recommended. The recommended evacuation system consists of two phases. The first one is called the "Primary Evacuation Areas" and constitutes the post-disaster assembly areas. The latter are called "Regional Evacuation Areas" and function as shelter areas and tent villages. In the report, both phases have been explained, and the criteria for their determination have been included as well. Within the Primary Evacuation Areas part of the chapter, the report also stated how much area per person there should be. According to the report, for all citizens and residents in the

area, the gross minimum area should be determined as 1.5 m^2 per capita. The report also states that the evacuation area should be selected from publicly-owned lands [11-13].

In another study, which examined the factors related to the planning of post-disaster assembly areas and shelter areas, it was stated that five criteria should be considered when determining the assembly areas. In the accessibility criterion, it is emphasized that the assembly areas should be accessible to every individual easily. The connection with the road axis is determined as the second criterion by this study. In the criteria for availability and multi-functionality, some of the areas that may be recommended as assembly areas are given as an example, and some examples of active and passive green areas are presented. Within the scope of this criterion, the requirement that the area should not be smaller than 500 m^2 comes to the forefront. In the context of ownership, as indicated in the report on Istanbul as well, it is stated that publicly-owned lands should be preferred as a priority. The study includes the area sizes in the last criteria, and provides several examples from other studies, in addition to the JICA and IMM reports, which determined the minimum areas as 1.5 m^2 per capita. For example, in another study, it is stated that the area should be determined based on building blocks, and it is recommended that it should be specified as 2 m^2 minimum as well [14-16].

3. Assessment of Post-Disaster Assembly Areas in Merkez District of Uşak Province

Uşak province has six districts in total; Central district, Banaz, Eşme, Karahallı, Sivaslı and Ulubey. According to TurkStat data [17], the population of the province was 312581 in 2018. A total of 75 post-disaster assembly areas have been determined in the entire province, and the areas are 2331880.81 m^2 in total. According to the statistical information received from the Provincial Disaster and Emergency Directorate, the status of the assembly areas in Uşak is shown in Table 1-4.

In the JICA and IMM reports, the gross minimum area per capita was indicated as 1.5 m^2. The area per capita standard that would be taken into consideration in this study would be 1.5 m^2 per capita, as in the JICA and IMM reports.

Accordingly, it is possible to make a general assessment from Table 1, when we look at the area sizes determined in the districts of Uşak province. The assembly areas are above the specified m^2 standard except for the Tatar town in Sivaslı district, which has no assembly area, and the center of Banaz district. In many districts and towns, the area per capita is quite above the determined standard. However, this assessment is not adequate since it is made based on the district. In the scope of this study, assembly areas will be evaluated in the neighborhoods of the Merkez/Uşak. The population data used in the study was obtained from the TurkStat [17] address-based population registration data for 2018. The names, addresses, status of the infrastructure and superstructure, and area sizes of the assembly areas were reached through the Uşak Provincial Disaster and Emergency Directorate and via e-Government. Accordingly, the infrastructure status, which is one of the seven criteria indicated by AFAD, would be examined as well. Then, the capacities of the areas were calculated, and it was identified which assembly area could serve a population of how many during an emergency. The size of the assembly area per capita in each neighborhood was calculated. Lastly, it was indicated whether the size of the area per capita was in compliance with the standards or not.

A total of 43 determined assembly areas in 28 neighborhoods of Merkez/Uşak are listed in Table 2. As is seen from Table 2, 11 of these 28 neighborhoods do not have any assembly areas.

According to inquiries via e-Government, when you click on any area in these neighborhoods, the three assembly areas that are closest to that area are listed and shown on the map.

When we analyze the neighborhoods that have assembly areas in the context of area per capita, 9 of them are not in compliance with the standards, as is seen from Table 4 (calculations made according to the specified 1,5 m^2 standard). In this context, the Kemalöz neighborhood, which has the most population, meets the standards as its area per capita is 2.9 m^2. Cumhuriyet and Atatürk neighborhoods are the two most populated neighborhoods after Kemalöz. Both of them are below the accepted 1.5 m^2 per capita standard. The area per capita in these populous neighborhoods is quite small, and there are also less populous neighborhoods that have less than 1 m^2 assembly area per capita. Besides, some neighborhoods are well above the standard, so the assembly areas could be used by those in their immediate vicinity as well.

Another criterion to be considered when determining the area is ownership. When we look at the Central District of Uşak, all assembly areas consist of parks and picnic areas and are all public ownership. According to the information obtained from the Provincial Disaster and Emergency Directorate, all assembly areas in Uşak province are composed of public ownership areas, and no expropriation has been mentioned.

Another criterion is the infrastructure status and whether it is capable of satisfying basic needs or not. In this context, the status of the electricity, water, and sewer systems of the assembly areas was examined and is indicated in Table 3. Water infrastructure in four of the 43 assembly areas is not capable of satisfying the needs. At the same time, in all of these four parks, the sewer system is not suitable either. The only park where electricity infrastructure is not suitable is Halil Kaya Gedik Park in the Fatih neighborhood. The biggest problem, in terms of infrastructure, is the sewer system. Twenty-three of the 43 assembly areas are not capable of satisfying the

sewerage related needs. In fact, sewage infrastructure is not suitable in all assembly areas in the neighborhoods of Aybey, Durak, Fevzi akmak, Işık, and slice.

Table 1. Statistical Information of the Post-Disaster Assembly Areas in the Districts of Uşak

District		The Number of Assembly Areas	Assembly Area (m^2)	Population	Area Per Capita (m^2)
Merkez	Merkez	43	1367350.42	252044	5.42
Banaz	Banaz	3	22150	16376	1.35
	Kızılcasöğüt Town	3	64500	1896	34.01
Eşme	Eşme	8	586470	14644	40.04
	Yeleğen Town	3	7815.39	2189	3.57
Karahallı	Karahallı	1	18570	5884	3.15
Sivaslı	Sivaslı	5	140869	7091	19,86
	Pınarbaşı Town	3	9000	1964	5.58
	Selçikler Town	2	22638	1922	11.77
	Tatar Town	-	-	1975	
Ulubey	Ulubey	4	92518	6596	14.02
Total		**75**	**2331880.81**	**312581**	

Table 2. Post-Disaster Assembly Areas in Merkez/Uşak

Neighborhood	No	Assembly Area	Neighborhood	No	Assembly Area
Atatürk	1	Şeker Park	Işık	26	Hacımlı Mehmet Park
	2	Krom Park		27	Vali Kadir Uysal Park
	3	Fevzi Çakmak Park	İslice	28	Fatih Park
	4	Akdemir Park	Kalfa		-
Aybey	5	Doğala Park	Karaağaç Köyü		-
Bozkurt	6	Çokkozlar Park	Karaağaç	29	Anıttepe Mesire Alanı
Çevre		-		30	Hilal Park
Cumhuriyet	7	Milli Egemenlik Park	Kemalöz	31	Batu Park
	8	Cumhuriyet Park		32	Yeni Garaj Park
	9	Akşemseddin Park		33	Toki Park
	10	Şirinkent Park		34	Göker Park
	11	Vural Park		35	Koru Park
	12	Faik Kökhan Park	Köme		-
Dikilitaş	13	Ilıcaksubaşı Park	Kurtuluş	36	Tiritoğlu Park
	14	Hitit Park		37	Dörtyol Park (Millet Bahçesi)
Durak	15	Aslan Park	Kuyucak		-
Elmalıdere	16	Depo Park	Mehmet Akif Ersoy	38	Akse Mesire Alanı
	17	Lamba Park		39	Çevre Park
Fatih	18	Çoban Çeşmesi Park		40	Meşe Park
	19	Yavuz Park	Muharremşah		-
	20	Alpaslan Park	Ovademirler		-
	21	Halil Kaya Gedik Park	Özdemir		-
	22	Masal Park	Sarayaltı	41	Filiz Park
Fevzi Çakmak	23	Kamer Park	Tekstil Osb		-
	24	Emre Park	Ünalan	42	Cavit Köksal Park
	25	Aysun Park		43	Karadede Park
Hacıkadem		-			
İkisaray		-			

Table 3. The Infrastructure and Superstructure Status of Post-Disaster Assembly Areas in Merkez/Uşak (✓: Available, X: Not Available)

POST-DISASTER ASSEMBLY AREAS INFRASTRUCTURE AND SUPERSTRUCTURE STATUS									
Neighborhood	No	Water	Sewer System	Electricity	Neighborhood	No	Water	Sewer System	Electricity
Atatürk	1	✓	X	✓	İkisaray				
	2	✓	X	✓	Işık	26	✓	X	✓
	3	✓	✓	✓		27	✓	X	✓
	4	✓	X	✓	İslice	28	✓	X	✓
Aybey	5	✓	X	✓	Kalfa				
Bozkurt	6	✓	✓	✓	Karaağaç Köyü				
Çevre					Karaağaç	29	✓	✓	✓
Cumhuriyet	7	✓	✓	✓		30	X	X	✓
	8	✓	X	✓	Kemalöz	31	✓	X	✓
	9	✓	✓	✓		32	✓	X	✓
	10	✓	✓	✓		33	X	X	✓
	11	✓	X	✓		34	X	X	✓
	12	✓	X	✓		35	✓	✓	✓
Dikilitaş	13	✓	✓	✓	Köme				
	14	✓	X	✓	Kurtuluş	36	✓	✓	✓
Durak	15	✓	X	✓		37	✓	✓	✓
Elmalıdere	16	X	X	✓	Kuyucak				
	17	✓	✓	✓	Mehmet Akif Ersoy	38	✓	✓	✓
Fatih	18	✓	✓	✓		39	✓	X	✓
	19	X	X	✓		40	✓	X	✓
	20	✓	✓	✓	Muharremşah				
	21	✓	X	X	Ovademirler				
	22	✓	✓	✓	Özdemir				
Fevzi Çakmak	23	✓	X	✓	Sarayaltı	41	X	X	✓
	24	✓	X	✓	Tekstil Osb				
	25	✓	X	✓	Ünalan	42	✓	X	✓
Hacıkadem						43	✓	✓	✓

Table 4. The Evaluation of Post-Disaster Assembly Areas in Merkez/Uşak [17-18]

Neighborhood	No	Area (m^2)	Capacity (Person)	Total Area	Neighborhood Population	Area Per Capita	Compliance with Standards
Atatürk	1	3564.24	2376	21301.65	20520	1.04	Non-compliant
	2	2759.45	1719				
	3	12967.93	8645				
	4	2010.03	1340				
Aybey	5	5324.77	3549	5324.77	7066	0.75	Non-compliant
Bozkurt	6	47624.93	31479	47624.93	1308	36.41	Compliant
Çevre		-			857		
Cumhuriyet	7	8471.84	5647	29322.37	30081	0.97	Non-compliant
	8	2164.89	1443				
	9	9378.18	6252				
	10	4658.39	3105				
	11	4649.07	3099				
	12	3855.56	2570				
Dikilitaş	13	250700.58	167.133	254449.6	16712	15.22	Compliant
	14	3749.02	2499				
Durak	15	1324.87	882	1324.87	4505	0.29	Non-compliant
Elmalıdere	16	9528.6	6352	20868.62	9607	2.17	Compliant
	17	11340.02	7560				
Fatih	18	17744.52	11829	114816.5	16652	6.90	Compliant
	19	13423.14	8948				
	20	44475.03	29650				
	21	27134.58	18089				
	22	12039.23	8026				
Fevzi Çakmak	23	3520.9	2347	12376.03	11399	1.09	Non-compliant
	24	3128.2	2085				
	25	5726.93	3817				
Hacıkadem		-			254		
İkisaray		-			224		
Işık	26	2082.71	1388	5700.49	4293	1.33	Non-compliant
	27	3617.78	2411				
İslice	28	2369.24	1579	2369.24	2308	1.03	Non-compliant
Kalfa		-			457		
Karaağaç Köyü		-			1887		
Karaağaç	29	369801.15	246.534	374490.88	14940	25.07	Compliant
	30	4689.73	3126				
Kemalöz	31	5008.78	3339	106099.06	36531	2.90	Compliant
	32	5350.83	3567				
	33	8672.51	5781				
	34	20776.41	13850				
	35	66290.53	44193				
Köme		-			1541		
Kurtuluş	36	3117.63	2078	4235.16	2624	1.61	Compliant
	37	1117.53	745				
Kuyucak		-			445		
Mehmet Akif Ersoy	38	348581.11	232.387	356057.12	10031	35.50	Compliant
	39	4361.94	2907				
	40	3114.07	2076				
Muharremşah		-			2082		
Ovademirler		-			1249		
Özdemir		-			633		
Sarayaltı	41	1924.58	1283	1924.58	8045	0.24	Non-compliant
Tekstil Osb.		-			17		
Ünalan	42	1228.44	818	6326.52	14012	0.45	Non-compliant
	43	5098.08	3398				

4. Examination of the Distrubution of Post-Disaster Assembly Areas With GIS

In this study, the distribution of the assembly areas in Merkez/Uşak has been examined by using the coordinates obtained from the Uşak Provincial Disaster and Emergency Directorate. The study examined the distribution of determined assembly areas in the district by using the neighborhood boundaries and satellite images. Using coordinate information, the locations of the assembly areas have been marked, and the distribution of these areas in the central neighborhoods has been shown with ArcMap 10.6. Figure 2 shows the locations and distribution of the 43 assembly areas according to the neighborhoods.

Assembly areas that are near to the center are more densely located, and their numbers and frequency decrease as they move away from the center. The areas that are far from the center comprise the areas that are generally larger and have more use as picnic areas. Towards the center, the parks, which are smaller and have the characteristics of neighborhood parks, are located as an assembly area. Especially as you move away from the center, the number of easily accessible assembly areas is small. However, some of the assembly areas that are easily accessible and too close to the buildings have some safety concerns, such as the collapse of buildings during an emergency.

The densities of the assembly areas are shown below in Figure 3, according to their distribution and area sizes. The Kernel Density map is prepared in ArcGIS with the Kernel Density tool by using the point features of the assembly areas. "The Kernel Density tool calculates the density of features in a neighborhood around those features. It can be calculated for both point and line features. " [19].

As is seen from the kernel density map and the information so far, high-density areas are the large-sized assembly areas far from the center. Even though the number of areas is higher in the center, their sizes are not even close to the ones with the highest density areas.

Another analysis in ArcGIS has been made using the Multiple Ring Buffer tool. This tool creates multiple buffers around the input with specified distances.

So, in this study, the distances were specified as 100, 300, and 500 meters around the assembly areas. Accessibility to assembly areas by each individual is crucial during an emergency. So, the walking distance to the assembly areas should be 500 meters or less [15, 20-21-22].

In that case, Figure 4 shows that assembly areas are not sufficient, even in central neighborhoods, in terms of accessibility. The distances of 100 and 300 meters from the assembly areas could serve only a very small area in each neighborhood. Even the maximum distance of 500 meters could not serve the whole neighborhood. So, in any emergency, assembly areas are not within easy access for many individuals.

5. Conclusion

Assembly areas are of vital importance during the first 12–24 hour period after the disaster. Therefore, its role in disaster management and planning is quite large. In the event of a disaster, it is very crucial to reach the people who are exposed to the disaster in the assembly areas in the shortest time possible. Therefore, the capacity should be sufficient to serve all citizens. Although areas that are large and capable of serving many people are considered favorable, the main point is the determination of building block-scale and neighborhood-scale assembly areas that can serve each settlement.

Easily accessible assembly areas would be lifesaving during a disaster, especially by raising public awareness about the areas beforehand. There should not be any problems in terms of infrastructure and superstructure in the assembly areas, and the areas should be in good condition to respond to the vital needs of the disaster victims. All of this is very valuable in the event of a possible disaster.

In this study, the compliance with the standards of the assembly areas in Merkez/Uşak has examined, and the distribution of these areas has also evaluated by using GIS. All 43 assembly areas determined in the district are located in the central neighborhoods, and some of these areas are not sufficient, especially in the populous neighborhoods. While 11 of the 28 neighborhoods do not have any assembly area, area per capita is below the accepted standard in 9 of the 17 neighborhoods which have an assembly area. Besides, most of the assembly areas have infrastructure problems, especially in sewage infrastructure.

In respect of the distribution of areas, while there is a more homogeneous distribution in some neighborhoods, there are problems, especially in neighborhoods where single and larger areas are determined as assembly areas. So, this distribution causes trouble in terms of accessibility to assembly areas. Also, the safety concerns such as collapse of buildings should be considered besides the accessibility. In the event of a disaster, accessibility to those areas in a safe way would be as important as the sufficiency of the areas. For this reason, easy-to-access areas that can respond to smaller settlements on the building block scale and neighborhood-scale should be determined as assembly areas.

The deficiencies in the assembly areas need to be corrected, and new assembly areas need to be determined in the neighborhoods where the areas are not sufficient. With GIS, the analysis and use of spatial and non-spatial data could be achieved easily. That's why it would be very advantageous using GIS to identify deficiencies of the assembly areas and to determine the new areas.

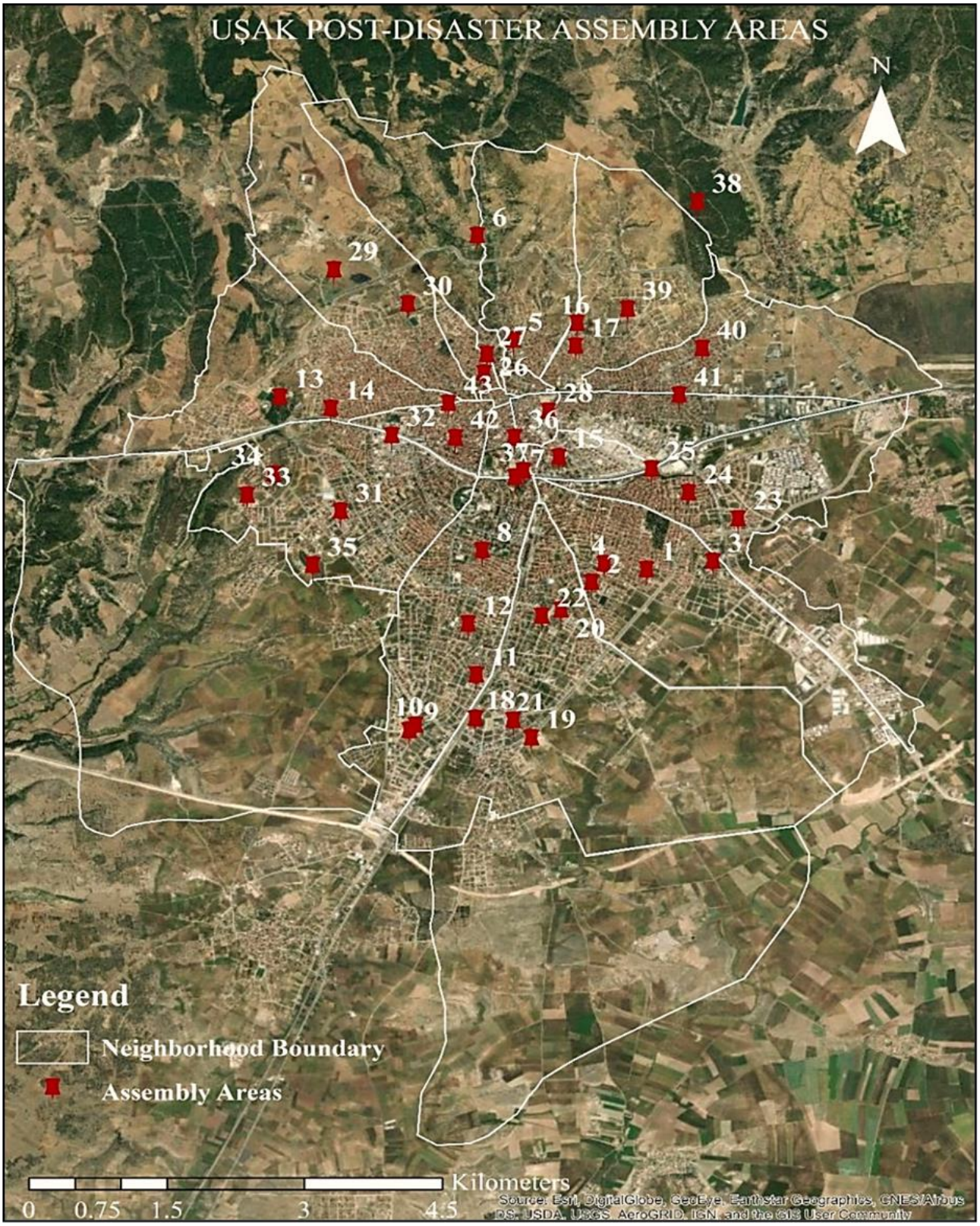

Figure 1. Distribution of the Post-Disaster Assembly Areas in Merkez/Uşak

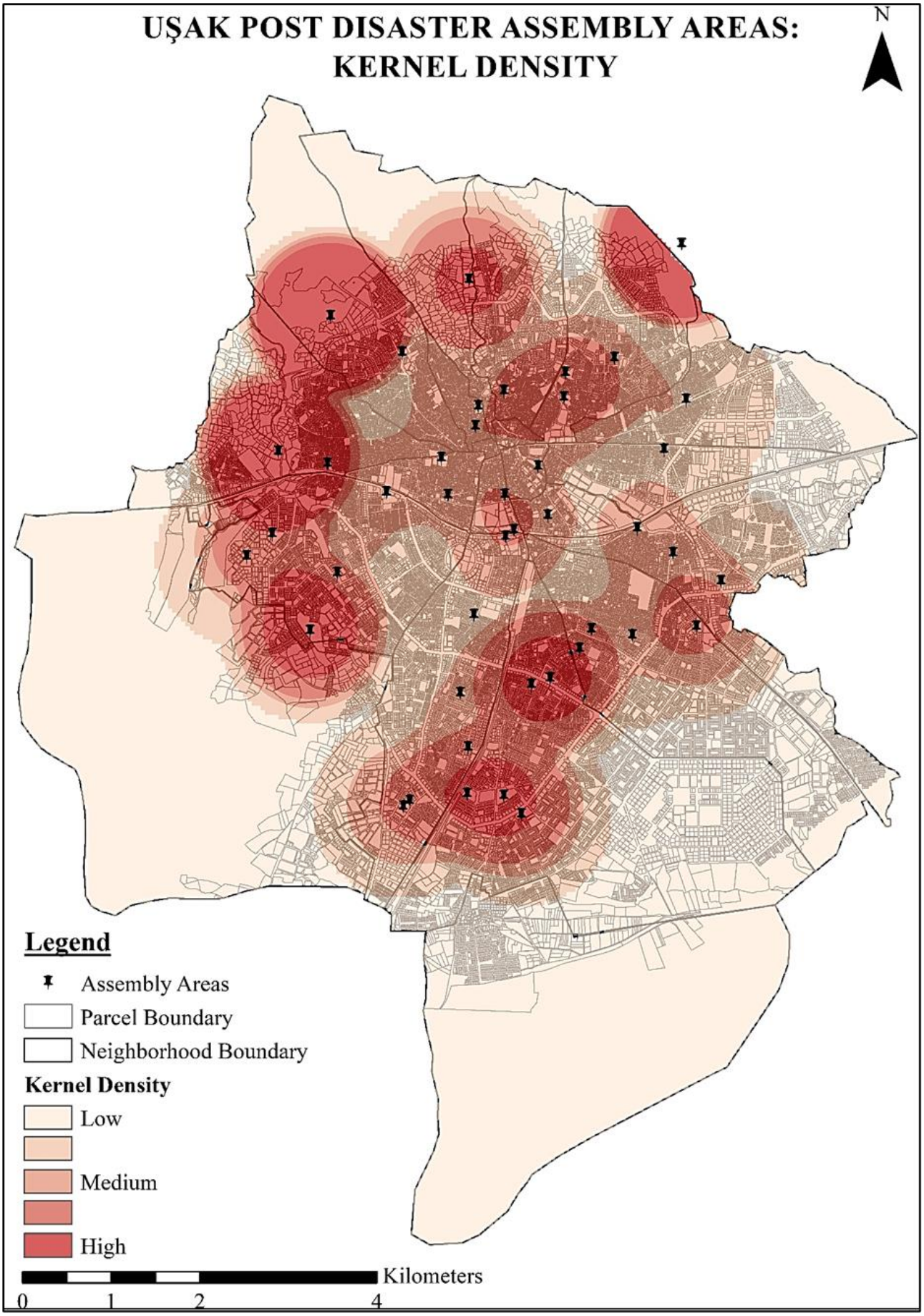

Figure 2. Merkez/Uşak Post-Disaster Assembly Areas: Kernel Density

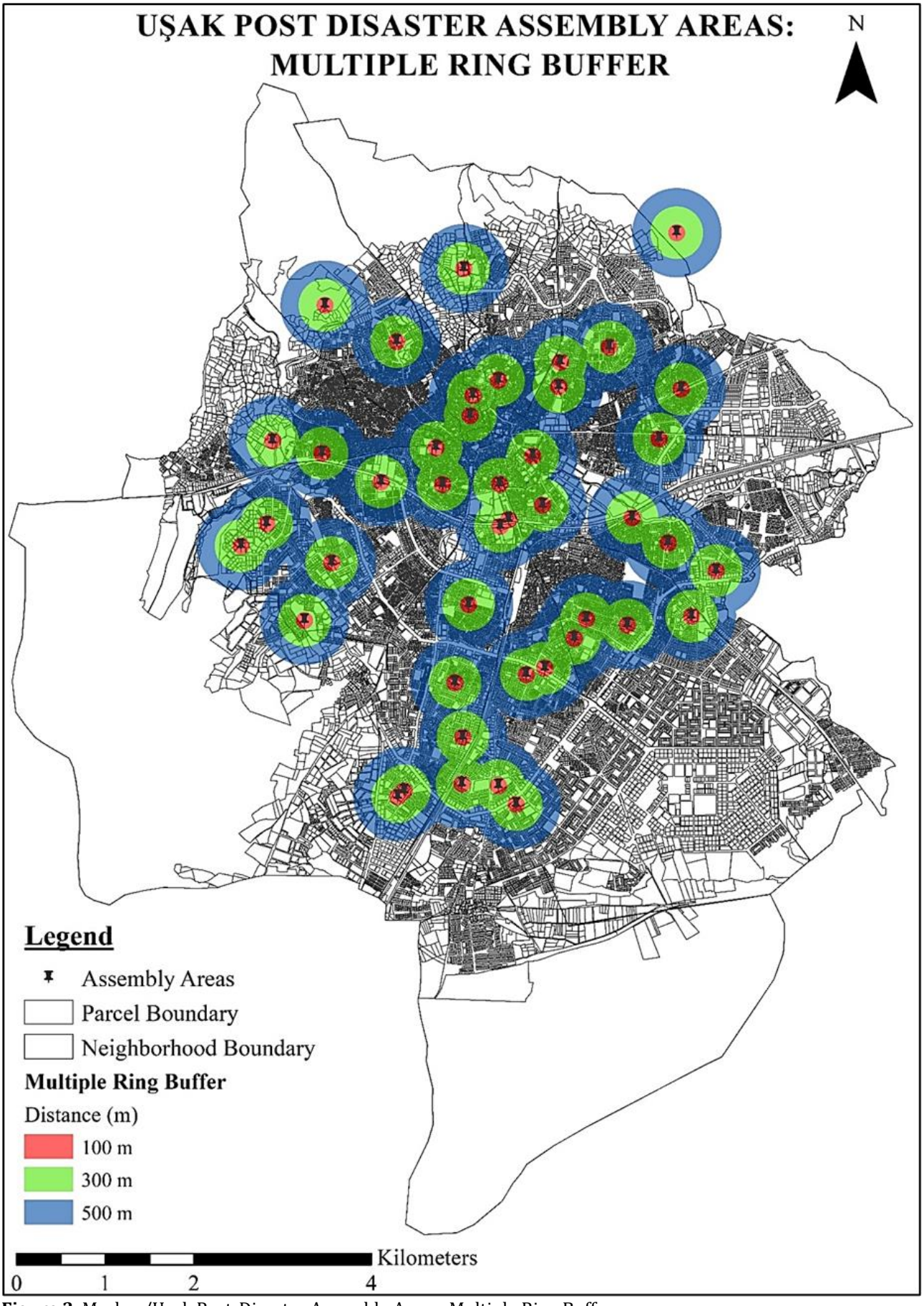

Figure 3. Merkez/Uşak Post-Disaster Assembly Areas: Multiple Ring Buffer

Funding

This research received no external funding.

Author contributions

Fatma Yüksel Doğruyol: Conceptualization, Methodology, Data curation, Software, Writing-Original draft preparation. **Fatih Taktak:** Visualization Reviewing and Editing.

Conflicts of interest:

The authors declare no conflicts of interest.

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