9.7. Port and Harbours

9.7.1. Realities of Harbors Facilities

As Istanbul faces the Bosporus Strait and Maramara Sea, many harbors are located along its waterside line. Figure 9.7.1 shows the locations of the main ports. While the details of the ports shown in Figure 9.7.1 (such as their functions, sizes and wharf structures) are yet to be known, the largest one is Haydarpaşa Port. The following is a summary of the current status of the Haydarpaşa Port:

Haydarpaşa Port is a harbor under control of TCDD and is one of the most important harbors in Turkey. Table 9.7.1 provides general information on the harbor facilities controlled by TCDD.

Table 9.7.1 Harbor of TCDD

PORTS OF TCDD	BERTH LENGTH (m)	PORT AREAS (*1000M2)	MAX DRAUGHT (m)	NUMBER OF WORKERS	TOTAL SHIP RECEIPT (Ships/year)	HANDLING CAPACITY (*1000Tons/Year)	BERTH CAPACITY (*1000 TEUS/Year)	CONTAINER BERTH EQUP.CAPACITY (*1000 TEUS/Year)	STORAGE CAPACITY	
									GENERAL CARGO (*1000 Tons/Year)	CONTAINER (*1000 TEUS/Year)
Haydarpaşa	2,765	320	-12	827	2,651	5,427	8,558	354	689	269
Mersin	4,605	994	-14.5	1,186	4,692	5,560	10,967	266	8,505	371
İzmır	2,959	902	-13	554	3,640	5,439	11,100	443	884	343
Samsun	1,756	588	-12	322	1,130	2,380	4,300	40	6,866	50
Bandırma	2,788	246	-12	282	4,280	2,771	7,008	40	2,013	50
Derince	1,092	312	-15	289	862	2,288	2,991	40	2,984	100
İskenderun	1,426	750	-12	567	640	3,247	6,097	20	9,286	146
Total	17,391	4,112		4,027	17,895	27,112	51,021	1,203	31,227	1,329

Source : TCDD THE GENERAL DIRECTORATE OF TURKISH STATE RAILWAYS PORTS DEPARTMENT

According to this table, Haydarpaşa Port handles approximately 20% of the total containers handled in Turkey though its port areas are smaller than some of the others'. Therefore, it is expected that when such port is struck by an earthquake and becomes unable to maintain its functions as a major port, the impact to not only Istanbul but to the whole Turkish economy would be very significant.

As a matter of fact, several facilities at harbors distributed on the seashore of Izmit Bay were seriously damaged by the Izmit Earthquake in 1999. While the extent of the damages varied depending on the sizes and types of the harbor structures and the ground conditions, 3 out of the 21 harbor facilities were seriously damaged and 9 were partially damaged. At Haydarpaşa Port, the damage by that earthquake was slight; namely, the earthquake only caused some cracks on the wharfs, and no port functions were influenced. However, the structure of the wharf at Haydarpaşa Port is of the gravity cellular block - pile type, the same type structure as the one at Derince Port, which was heavily damaged by the Izmit

Earthquake, and particularly because the backside of the gravity cellular block is filled with sand, liquefaction of sand and sliding destruction are expected. For this reason, it is desirable to evaluate the resistance against earthquakes of Haydarpaşa Port and other major ports and to enhance or reinforce their structures as required in order to prevent damages from future earthquakes.

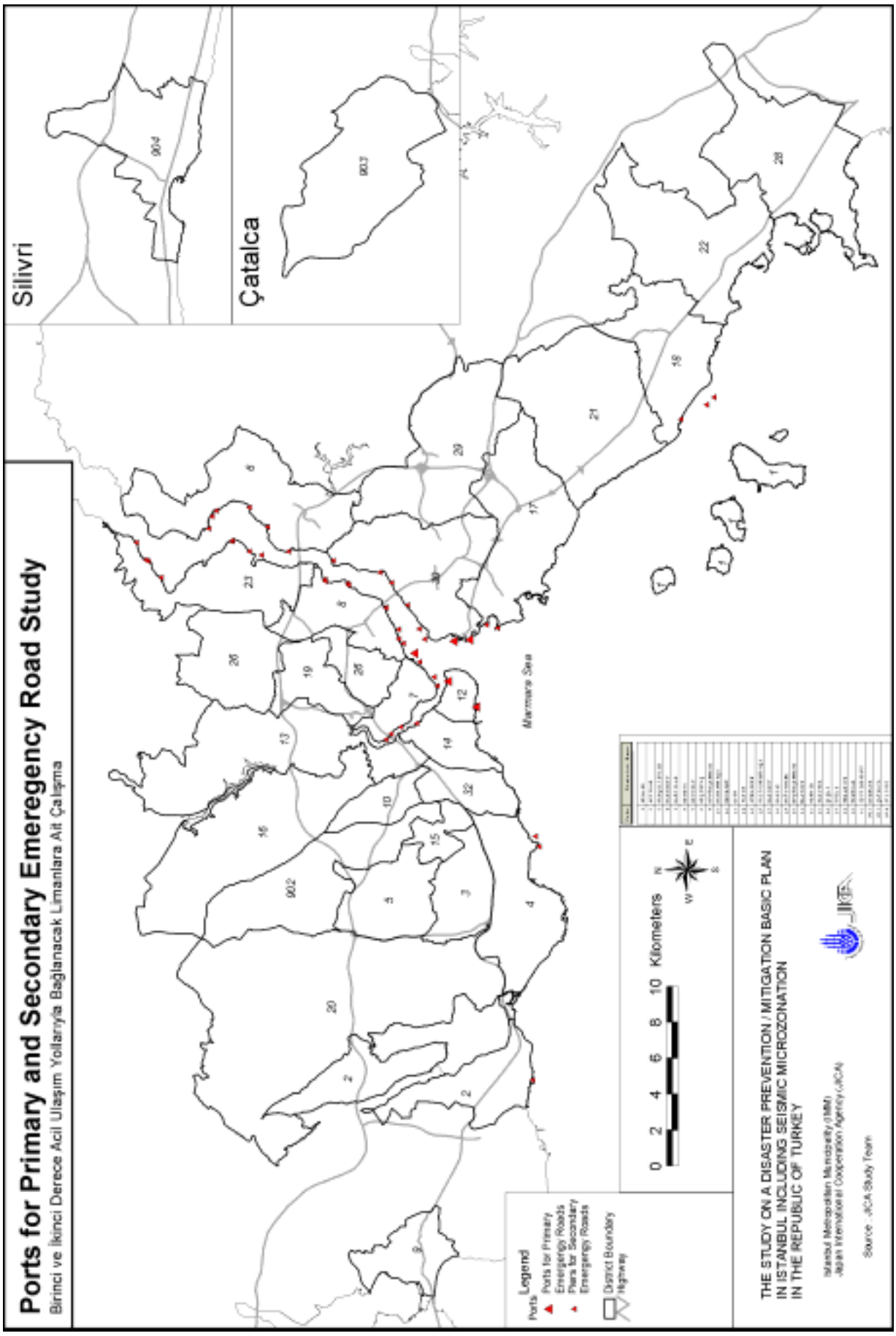


Figure 9.7.1 Ports for Primary and Secondary Emeregency Road Study

9.7.2. Role of Port in Emergency

The Kobe-Awaji Earthquake seriously damaged many harbor facilities. The damage caused by the earthquake significantly influenced economic and social activities over a wide area, but because the harbor, as the centre for promoting resuscitation and reconstruction, was increasingly utilised in various ways recovery efforts made progress, the importance of the harbor has been recognised among people once again. As a result of this recognition, not only has the harbor's function been enhanced, but also several measures to strengthen the harbor as the disaster prevention centre have been carried out.

In Istanbul, the main traffic systems, which serve to move people and to transport goods, include roads that connect the east and west areas (the national traffic axes), airports, and harbor facilities. Because of Istanbul's geographical conditions (it is surrounded by seas and has a continuous waterside line), many small and large harbor facilities have been constructed there. Some of these harbor facilities serve asstorage terminals for handling international cargos, wharfs for large passenger ferries and other small ferries, and facilities for fishing boats. Such being the situation, when the area is struck by an earthquake and road functions become paralyzed or dead, harbors are expected to perform various functions such as storage of external relief supplies, transport of supplies to the disaster areas, treatment and transport of debris and garbage, providing of shelter, etc. In order for harbor facilities to perform their functions as expected after an earthquake, the following maintenance of harbors is required:

Establishment and enhancement of harbor facility's earthquake-resistance based on importance

In addition to the ordinary functions, which have to be fulfilled as part of daily operations, a harbor facility is required to serve various functions after an earthquake. These include services needed during the stages of evacuation, rescue, restoration, resuscitation, etc. Therefore, it is necessary to establish preventive measures against earthquakes taking into consideration the importance of the functions required after an earthquake and the eases of restoration, in addition to the importance of the functions required for daily operations. Furthermore, in order for a harbor to be able to perform as a terminal immediately after an earthquake, it is necessary that its harbor facilities be properly laid out and that its resistance against earthquakes be strengthened. To achieve this, it is necessary to enhance the earthquake resistance not only of wharfs but also of facilities for storage and landing, as well as access routes.

Enhancement of harbor's functions as disaster prevention base

Because sea traffic is comparatively stable against earthquakes and can handle a large volume transportation, harbors have excellent characteristics that would make them suitbale as bases for transportation immediately after an earthquake. In Istanbul, several harbors have the conditions under which this function can be expected thanks to the geographical advantage that its urban districts face the waterside line. These harbor facilities have space that is flexible and available for the land use requests to serve various purposes from the periods immediately after an earthquake to the stages of restoration and recovery. In order to broadly contribute to the restoration and recovery efforts in the disaster areas, it is important to enhance the functions of harbors as the transportation bases for relief supplies and as the bases for restoration and recovery activities, taking advantage of the fact that harbors have such space. In this case, it is also important not only to enhance harbor facilities, such as wharfs, but also to ensure the preservation or development of space behind the facilities ready for emergency use, so that facilities and this space can be utilised as one unit to cope with the disaster.

Establishment of cooperation system among harbor facilities

As explained above, many harbor facilities are located in Istanbul, and it is important to strengthen the harbor system so that, after an earthquake, all harbor facilities cooperate with each other and play individual roles according to their sise and function.

9.7.3. Improving Earthquake Resistance of Harbor Facilities

In Turkey, harbor facilities are not classified according to their functions or importance. However, it is possible to classify them into "important ports in the international sea transportation network," "important ports in the domestic sea transportation network," and "others," as shown below:

Highly Important Ports: Samsun (TCDD), Kdz. Ereğli, H.Paşa (TCDD), TDİ İstanbul Salıpazarı Yolcu Limanı, Ambarlı Liman Tesisleri, Derince (TCDD), Sedef Liman Tesisleri, Gemlik, Bandırma (TCDD), İzmir Alsancak (TCDD), Kuşadası, Antalya, Mersin (TCDD), Yumurtalık-ATAŞ (Fueloil Port), İskenderun (TCDD) Limanları sayılabilir.

Important Ports: Hopa, Rize, Trabzon, Giresun, Sinop, Zonguldak, Bartın (now on going project and construction), Tekirdağ, Çanakkale, İzmir-Aliağa (Cargo-Fueloil), Mersin-Taşucu, İskenderun-İsdemir Limanları sayılabilir.

Local Ports: other facilities which provide sight-seeing services and fishing ports.

Regarding the enhancement and reinforcement of earthquake resistant harbor facilities, activities aimed at earthquake-proofing harbors seem to have been continuously carried out at TCDD's Mersin and İzmir Alsancak Ports, etc., but it is also necessary to take measures to improve the earthquake resistance of both facilities, such as wharfs, and disaster prevention bases from now on.

In improving the earthquake resistance of harbor facilities, not only is the improvement of wharfs and other harbor facilities necessary, but also the improvement of harbors as awhole. Namely, it is also necessary to thoroughly study the improvement of earthquake-proof access routes that connect harbors and the cities behind them, as well as the maintenance of routes from various viewpoints.

9.7.4. Importance of Developing Disaster Prevention Bases in Harbors

Many of harbor facilities have open spaces such as green tracts of lands and terminals. These open spaces can be used for many purposes, such as a construction base for restoration activities, a site for temporary houses, a makeshift dump yard for debris of buildings and garbage, etc. It is, therefore, extremely effective to develop the harbor space as a disaster prevention base thoroughly recognising its excellent characteristics. Explained in the following are basic suggestions regarding the maintenance of harbors to be utilised as disaster prevention bases:

Maintenance of Disaster Prevention Base

Harbors have open spaces which can be used for many purposes, several attached facilities (such as berths, cranes, etc.), harbor roads adjacent to the open spaces, etc. Taking these characteristics into consideration, it is desirable to proceed with the development and maintenance of harbors as disaster prevention bases. These bases havefacilities for storage of emergency supplies to cope with the earthquake disaster, for the relaying of communication and information, and for temporary disposal of debris and garbage, if the the harbor's existing open spaces, facilities, and roads are utilised according to their layout.

Maintenance of Shelter Green Tract of Land

It can be expected that green tracts of land in harbor facilities function as seaside green parks, making the surrounding scenery better during ordinary times. In emergency cases such as during an earthquake, the green tract of land itself becomes a facility having a disaster preventive function. From this viewpoint, it is desirable to positively proceed with the maintenance of green tracts of land, giving consideration to the layout of facilities, various lines of flows, open spaces, etc.

Importance of Disaster Prevention of Harbors Space

Some harbors have facilities such as storage tanks of flammable materials, which can contribute to a secondary disaster after an earthquake. Furthermore, when a tsunami strikes, the harbor facility itself can be damaged. Such being the case, it is necessary to give careful consideration to secure harbor facilities from these potential dangers. Also, in order to be able to easily support the restoration activities when secondary disasters occur, it is important to secure safe spaces by utilising water and greenery and through the maintanence of harbor facilities and wide roads connected to the facilities.

In Istanbul, relatively large harbor facilities are located at both sides of the Bosporus Strait. In addition, many small and large harbor facilities are found on the coasts of the Golden Horn Inlet and Malmara Sea. Such being the situation, it is thought that more effective disaster prevention measures can be achieved through cooperation among harbor facilities in times of emergency, as well as through the proper maintenance of the individual disaster prevention bases. The network formed by small and large harbor facilities in times of emergency makes it possible to implement properly organised relief activities. Such activities include the transportation of debris and restoration materials by large ships and that of miscellaneous goods by small ships, so that a comparatively smooth transportation of goods to urban districts can be secured even in an emergency. As Haydarpaşa Port has a transportation facility for container cargos and can be connected to relatively wide harbor roads, it is thought that more effective disaster prevention function can be secured by recognising Haydarpaşa Port and its surrounding areas as primary disaster prevention facility. A network, which connects Haydarpaşa Port and its surrounding areas with other harbor facilities, should also be established. Incidentally, Haydarpaşa Port and its surrounding areas have a continuous seaside line facing the Bosporus Strait, and historical buildings and rows of houses on the other side can be seen from there. Therefore, it can be expected that well-maintained disaster prevention bases having open spaces and green tracts of land can be utilised as resources for sight-seeing because they can function as waterside parks, etc., in ordinary times.

Chapter 10.
Preparedness Measures to Strengthen Vulnerable Building and Urban Structure

Chapter 10. Preparedness Measures to Strengthen Vulnerable Building and Urban Structures

10.1. Vulnerability Analysis of Building and Urban Structures in Istanbul

10.1.1. Relationship between Greater Earthquake Disaster Damages and the Vulnerability of Building and Urban Structures

In the case of an earthquake disaster affecting the IMM, identified vulnerable conditions of buildings and urban structures will not only cause direct damages to buildings and lifelines and cause human casualties, but these will also contribute to secondary disasters. These secondary disasters will expand disaster damages into a greater region-wide catastrophe, owing to delayed emergency response systems. Areas with potential for serious damage have been identified as follows:

- **Estimated Strong Earthquake Motion Area:** coastal area and islands of Marmara Sea are in the precarious situation of being near the active fault of north Anatolia.
- **Estimated High Building Damage Area:** lack of seismic resistant structures (squatter and irregular development areas) located in the estimated strong seismic motion area.
- **Lack of Safety Evacuation Routes:** lack of sufficiently wide evacuation routes.
- **Lack of Safety Evacuation Spaces:** lack of or limited parks and open spaces to provide evacuation spaces to residents protecting them from second and third earthquake motions.
- **Lack of Access Roads for Emergency Vehicles**: areas generally connected by inappropriately narrow roads will be isolated and probably will not be reached by proper emergency response operations, such as rescue, fire fighting, first aid, emergency medical care, and emergency food/water supply.
- **Lack of Emergency Response Resources:** lack of emergency response centres and required manpower, machinery, and others for rescue, fire fighting, first aid, emergency medical service, and the provision of emergency supplies.
- **Vulnerable Lifeline Network Systems:** residents will not survive without lifeline services (even those refugees in buildings without serious damage).

- **Hazardous Areas of Secondary Disasters:** concentrated hazardous facilities and liquefaction potential areas will trigger fire outbreaks and explosions due to hazardous materials, natural gas pipeline networks, and electric power supply networks lacking proper security system.
- **Lack of Reliable Primary Damage Information Collection System:** without reliable information, limited emergency response resources will not be properly dispatched or distributed, which, if inappropriately mobilized, will result in more serious human casualties and secondary disasters in heavily damaged areas.

The relationship between disaster damages and vulnerabilities depicted by the following flow chart brought out issues to warrant the formulation of an urban disaster prevention plan:

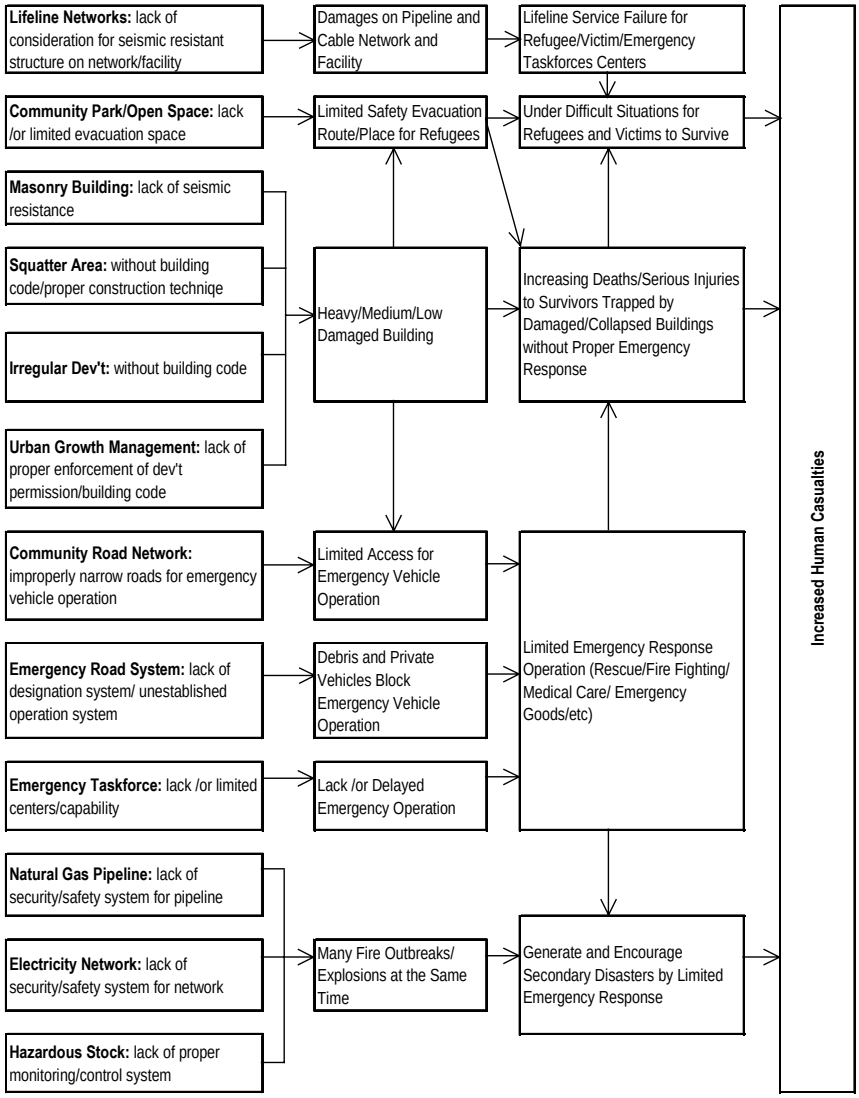


Figure 10.1.1 Relationship between Greater Disaster Damage and Vulnerable Buildings and Urban Structure

Source: The JICA Study Team

10.1.2. Analysis Flow for Building and Urban Structure Vulnerability

The following study is recommended in order to formulate measures to strengthen vulnerable buildings and urban structures in order to mitigate disaster damages.

In the Study, factors of vulnerability are assessed with regards to two main areas: building structures and urban structures. In addition, a land availability analysis is included to identify areas for future urban structure improvement and required urban redevelopment.

Recommended measures are as follows:

	Vulnerable: Building/Urban Structure	Not So Vulnerable: Building/Urban Structure
Available: Land for Urban Structure Improvement	Building/Urban Structure Improvement Area	Building Improvement Area
Not Available: Land for Urban Structure Improvement	Urban Redevelopment Area	Building Improvement Area

The vulnerability study is implemented and assessed on the basis of 642 mahalles, which are the statistical units in Istanbul. The databases utilized for 8 analytical exercises on 3 main fields are as follows:

1) Present Vulnerability of Buildings:

- Estimated Building Damage: the result (sum of the estimated heavily and moderately damaged building ratios for each mahalle) of the JICA Microzonation Study. The estimated building damages are the result of a complex analysis of the earthquake motion (estimated on earthquake scenarios, ground condition, etc.) and building condition (with damage function) for each mahalle.
- Trend of Building/Urban Structure Renewal: the results (year of construction data) of the 2000 Building Census and the Chronological Urban Expansion Map in the Master Plan of IMM.

2) Present Vulnerability of Urban Structures:

- Excessively High Land/Building Use by Urban Development Type: the results (data on plot area, building coverage area, and number of floors) of the 2000 Building Census.
- Road Density (m/ha) in Urbanized Area: GIS road network database, updated GIS mahalle map, and GIS building/built-up/urbanized area database compiled by the JICA Study Team.

- Narrow Roads Ratio: GIS road network database with road width information and GIS mahalle map developed by the JICA Study Team.
- Availability of Parks and Open Space for the Required Community Evacuation Areas: the list of parks and open spaces in Istanbul, which was created by the study of parks/open space availability in Istanbul (through Istanbul University supported by the Mapping Directorate of the IMM).
- Cut-off Point for Necessity of Strategic Improvement Measures: the complex factor of earthquake and building vulnerability (less than 10% of heavily/ moderately damaged building ratio for each mahalle)

3) Land Availability for Urban Structure Improvements:

- Built-up Area Ratio in Urbanized Area: the results (plot area data) of the 2000 Building Census and GIS building/built-up/urbanized area database compiled by the JICA Study Team.
- Average Net Building Coverage Ratio in Built-up Area: the results (plot area data and building coverage area data) of the 2000 Building Census.

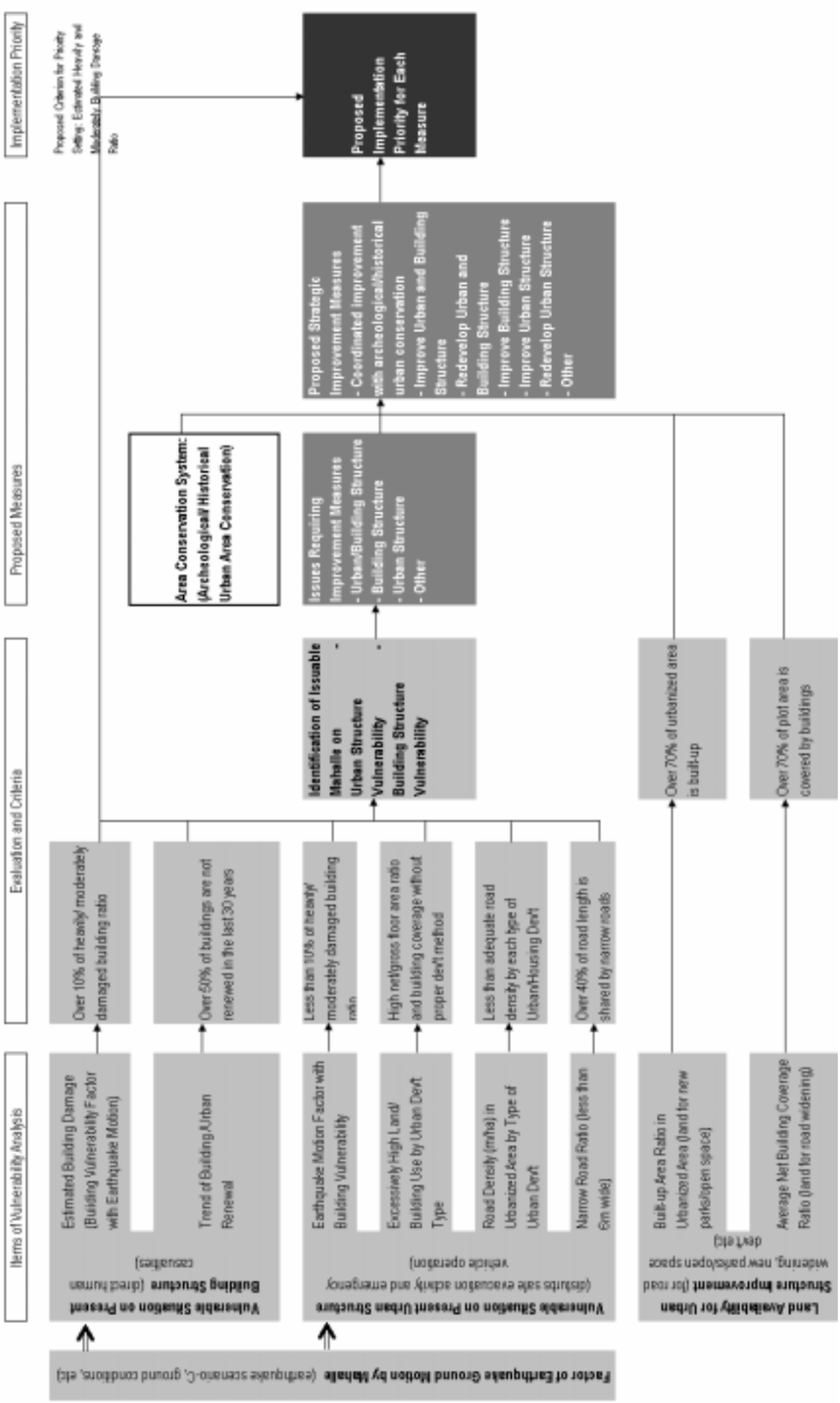


Figure 10.1.2 Flow Chart of Vulnerability Analysis of Buildings and Urban Structures

Source: The JICA Study Team

10.1.3. Estimated Building Damages

In the JICA Microzoning Study, building damages are estimated for each of the four earthquake scenarios. In the Study, the estimated building damages of Scenario Earthquake C, which is the worst scenario for Istanbul, are used in the building vulnerability study. Building share of the estimated heavily and moderately damaged buildings in each mahalle is categorized and assessed according to the vulnerability of building structure, which will require strengthening of seismic resistance in the future with appropriate public assistance by the implementation of technical, financial, and taxation measures.

Based on the estimated heavily and moderately damaged building percentages, the mahalle building damages can be categorized as follows:

1) over 40% (over 63% total): catastrophically damaged mahalle

2) 30 to 39% (52 to 68% total): heavily damaged mahalle

3) 10 to 29% (26 to 58% total): moderately damaged mahalle

In the analysis, percentages 10% and above of heavily and moderately damaged buildings denote mahalles as those with vulnerable building structures.

Table 10.1.1 Share of the Estimated Building Damage by Mahalle: Model C

Sum of Heavily and Moderately Damaged	Heavily Damaged	Moderately Damaged	Partially Damaged	Total Damaged Buildings	Damage Situation	
over 50%	33 - 41%	18 - 23%	18 - 22%	74 - 80%	Catastrophic Damaged Mahalle	Vulnerable Building Structure
45 - 50%	24 - 31%	17 - 23%	20 - 28%	66 - 76%		
40 - 45%	20 - 27%	17 - 22%	21 - 28%	63 - 73%		
35 - 40%	17 - 22%	15 -22%	22 - 29%	58 - 68%	Heavily Damaged Mahalle	
30 - 35%	14 - 18%	14 - 18%	21 - 29%	52 - 63%		
25 - 30%	12 - 16%	13 - 16%	21 - 29%	47 - 58%	Moderately Damaged Mahalle	
20 - 25%	8 - 12%	11 - 15%	20 - 28%	41 - 53%		
15 - 20%	6 - 9%	8 - 12%	19 - 26%	34 - 46%		
10 - 15%	3 - 7%	6 - 9%	16 -24%	26 - 38%		
5 - 10%	2 - 4 %	3 - 6%	11 - 20%	16 - 30%		
0 - 5%	0 - 2%	0 - 3%	3 -15%	4 - 20%		

Source: The JICA Study Team

The results of the building vulnerability analysis are as follows:

1) **Catastrophically Damaged Mahalles**: 54 mahalles (8% of total) are located only in The Historic District, on the Marmara Coast and Inland Area of the European side and on the Adalar Islands.

2) **Heavily Damaged Mahalles**: 105 mahalles (16% of total) are more widely distributed, except in the northern Bosphorus areas.

3) **Moderately Damaged Mahalles**: 298 mahalles (46% of total) are distributed in almost all districts except Çatalca and Adalar (all mahalles with settlements in these districts are assessed as Catastrophically or Heavily Damaged Mahalles).

The number of mahalles assessed as having vulnerable building structures are 457, which account for 71% of the 642 mahalles in the Study Area. The assessed vulnerable mahalles are concentrated in The Historic District (143 mahalles, 97% of mahalles in the area), on the Marmara Coast of the European side (58 mahalles, 98% of mahalles in the area), in the Inland Area of the European side (52 mahalles, 87% of mahalles in the area), and the Marmara Coast and Islands of the Asian side (105 mahalles, 88% of mahalles in the area), as follows:

Table 10.1.2 Building Damage Situation and Building Vulnerability by Mahalle

Area	District		Number of Mahalles							
	Code	Name	Catastrophic Damaged		Heavily Damaged		Moderately Damaged		Vulnerable Mahalle	
			Mahalle	%	Mahalle	%	Mahalle	%	Mahalle	%
Old Town	12	EMINÖNÜ	6	18	7	21	17	52	30	91
	14	FATİH	11	16	41	59	17	25	69	100
	7	BEYOĞLU	6	13	8	18	30	67	44	98
	Sub-Total		23	16	56	38	64	44	143	97
Europe: Marmara Coast	32	ZEYTİNBURNU	8	62	3	23	2	15	13	100
	4	BAKIRKÖY	10	67	4	27	1	7	15	100
	15	CÜNGÖREN	0	0	8	73	3	27	11	100
	3	BAHCELİEVLER	1	9	7	64	3	27	11	100
	2	AVCILAR	4	44	3	33	1	11	8	89
	Sub-Total		23	39	25	42	10	17	58	98
Europe: Bosphoras	8	BEŞİKTAŞ	0	0	1	4	9	39	10	43
	19	KAĞITANE	0	0	0	0	10	53	10	53
	26	ŞİŞLİ	0	0	0	0	11	39	11	39
	23	SARIYER	0	0	0	0	1	4	1	4
	Sub-Total		0	0	1	1	31	33	32	34
Europe: Inland	13	EYÜP	0	0	1	5	14	70	15	75
	16	GAZİOSMANPAŞA	0	0	0	0	13	45	13	45
	10	BAYRAMPAŞA	1	9	5	45	4	36	10	91
	902	ESENLER	0	0	2	11	11	61	13	72
	5	BAĞCILAR	0	0	0	0	21	95	21	95
	20	KÜCÜKCEKMECE	3	13	4	17	13	57	20	87
	Sub-Total		4	3	12	10	76	62	92	75
Total/Average of European Side			50	12	94	22	181	43	325	77
Asian: Marmara	1	ADALAR	4	36	2	18	0	0	6	55
	17	KADIKÖY	0	0	1	4	25	89	26	93
	21	MALTEPE	0	0	1	5	16	76	17	81
	18	KARTAL	0	0	0	0	19	95	19	95
	22	PENDİK	0	0	3	10	24	83	27	93
	28	TUZLA	0	0	2	18	8	73	10	91
	Sub-Total		4	3	9	8	92	77	105	88
Asian: Bosphoras	30	ÜSKÜDAR	0	0	0	0	16	30	16	30
	6	BEYKOZ	0	0	0	0	2	11	2	11
	29	ÜMRANİYE	0	0	0	0	2	14	2	14
	Sub-Total		0	0	0	0	20	23	20	23
Total/Average of Asian Side			4	2	9	4	112	54	125	60
Outside IMM	9	BÜYÜKCEKMECE	0	0	2	33	3	50	5	83
	903	CATALCA	0	0	0	0	0	0	0	0
	904	SİLİVRİ	0	0	0	0	2	40	2	40
	Sub-Total		0	0	2	15	5	38	7	54
Total			54	8	105	16	298	46	457	71

Source: The JICA Study Team

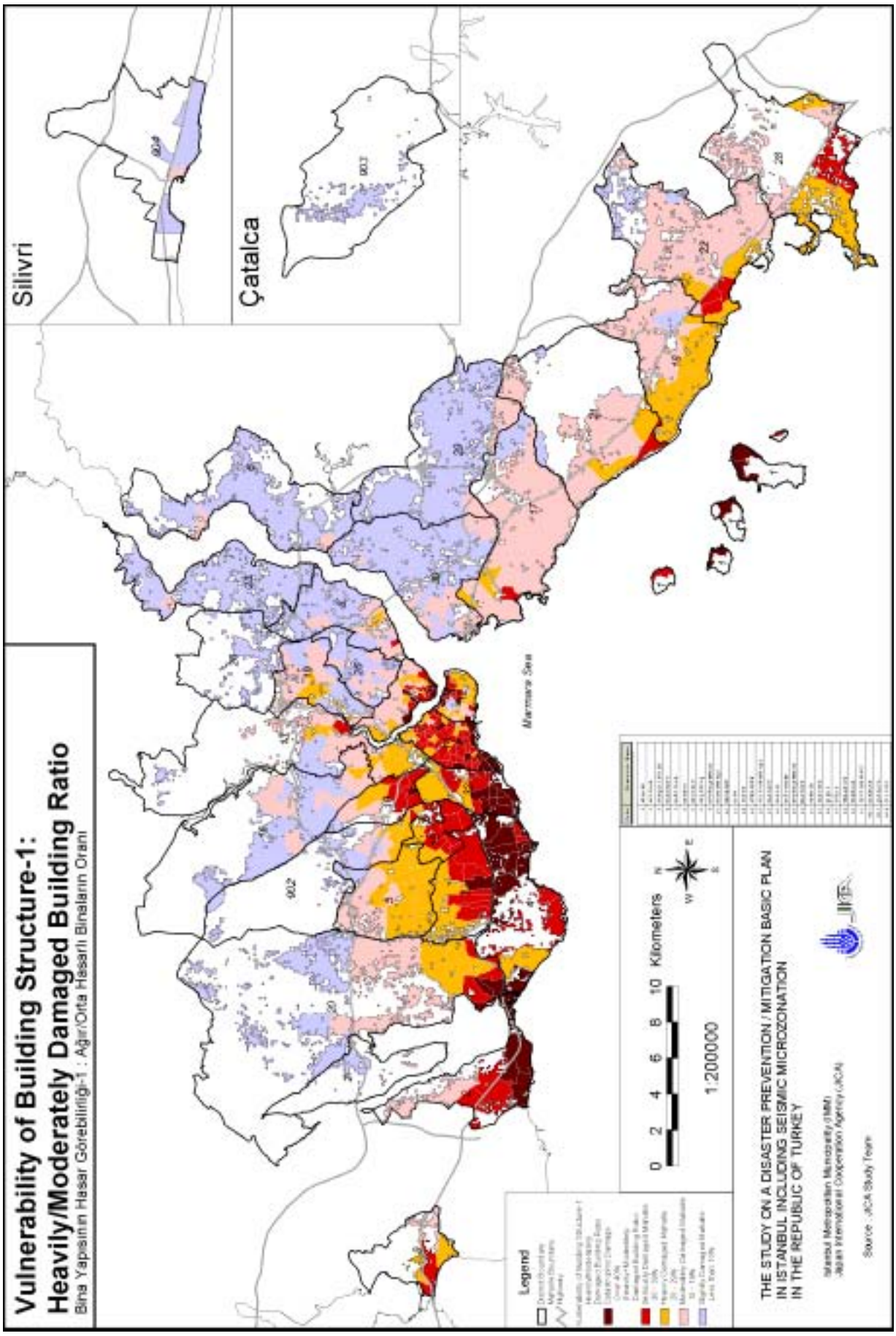


Figure 10.1.3 Heavily/Moderately Damaged Building Ratio

10.1.4. Trends of Building/Urban Renewal

Past trends of building reconstruction activities in each mahalle represent enhanced socio-economic activities to adapt to the needs of modern society. Also, those trends could be understood as upgrading to better building structures and representing progress of urban renewal with appropriate road and urban infrastructure improvements in each mahalle.

As part of the analysis, the superposition of the Chronological Urban Expansion Map of the IMM's Master Plan and the construction year data from the 2000 Building Census show building reconstruction and urban renewal trends for each mahalle over the past three decades. However, a major part of the presently urbanized mahalles are shared and were developed after the year 1970, which is categorized as a developing stage to maturity of urbanization in the past three decades. Building reconstruction and urban renewal trends could not be assessed for those mahalles based on limited data.

In the study, trends of building reconstruction and urban renewal over the past 3 decades are assessed into 3 categories, as follows:

- **Mahalle Characterized by Low and Delayed Urban Renewal:** more than half of buildings have not been reconstructed.
- **Mahalle Characterized by Moderate Urban Renewal Mahalle:** 50 to 75% of buildings have been reconstructed.
- **Mahalle Characterized by High Urban Renewal Mahalle:** over 75% of buildings have been reconstructed in the period.

In areas of the Bosphorus Strait and The Historic District and its surroundings, , areas developed before the 20th century were designated as archeological world heritage sites and historical conservation areas by UNESCO and the Government of Turkey. Many weak traditional urban structures and traditional alleyways, which are presently protected under the conservation regulation, remain in these designated areas. Furthermore, these building structures could not be assessed as to their earthquake resistance for the forecasted earthquake motion, and so, it is estimated that these areas will suffer heavy building damage. The national conservation policy for historical urban area is required to reconsider its regulation from the following point of views:

- To provide a safe environment for citizens in the event of an earthquake disaster
- To support the private sector's reconstruction activities to strengthen the presently weak buildings by technical, financial, and taxation measures

- To provide and introduce a safer road network for residents in the area (the current traditional alleyway system cannot be used for evacuation routes by citizens or as roads for emergency response operations (areas will be isolated)
- The historical urban areas' strict conservation system, without additional supporting measures, is creating slums and ghost towns. Current alleyways cannot adapt to the needs of a modern society, which is discouraging a trend of self-reconstruction of buildings in the area.

Table 10.1.3 Status of Building and Urban Renewal Trends by Mahalle

Area	District		Low Reconstruction Rate less than 50%		Medium Reconstruction Rate 50 to 75%		High Reconstruction Rate over 75%		Newly Urbanized Mahalle		Total of District	
	Code	Name	Mahalle	Area (ha)	Mahalle	Area (ha)	Mahalle	Area (ha)	Mahalle	Area (ha)	Mahalle	Area (ha)
Old Town	12	EMINÖNÜ	20	312	10	134	3	62	0	0	33	508
	14	FATİH	29	422	26	419	14	205	0	0	69	1,045
	7	BEYOĞLU	28	356	11	290	6	243	0	0	45	889
	Sub-Total		77	1,090	47	843	23	510	0	0	147	2,443
Europe: Marmara Coast	32	ZEYTİNBURNU	1	142	0	0	10	940	2	67	13	1,149
	4	BAKIRKÖY	4	1,488	4	799	6	307	1	357	15	2,951
	15	CÜNGÖREN	0	0	1	83	0	0	10	636	11	718
	3	BAHÇELİEVLER	0	0	0	0	0	0	11	1,661	11	1,661
	2	AVCILAR	0	0	5	819	0	0	4	3,042	9	3,861
	Sub-Total		5	1,630	10	1,701	16	1,248	28	5,762	59	10,340
Europe: Bosphoras	8	BESİKTAŞ	3	231	12	991	8	588	0	0	23	1,811
	19	KAĞITANE	0	0	2	64	3	352	13	945	18	1,362
	26	ŞİŞLİ	11	357	9	508	4	163	4	2,516	28	3,543
	23	SARIYER	1	136	9	1,242	2	352	11	1,045	23	2,774
	Sub-Total		15	724	32	2,805	17	1,455	28	4,506	92	9,489
Europe: Inland	13	EYÜP	1	42	10	721	6	1,500	1	142	20	5,050
	16	GAZİOSMANPAŞA	2	93	7	364	0	0	19	2,310	29	5,676
	10	BAYRAMPAŞA	0	0	1	23	10	936	0	0	11	958
	902	ESENLER	0	0	0	0	0	0	18	3,890	18	3,890
	5	BAĞCILAR	0	0	7	375	0	0	15	1,819	22	2,194
	20	KÜÇÜKÇEKMECE	0	0	3	273	1	132	18	9,501	23	12,173
	Sub-Total		3	136	28	1,756	17	2,567	71	17,663	123	29,942
Total/Average of European Side			100	3,579	117	7,104	73	5,780	127	27,930	421	52,214
Asian: Marmara	1	ADALAR	3	201	1	48	2	151	0	0	11	1,100
	17	KADIKÖY	1	60	6	485	16	2,398	5	1,185	28	4,128
	21	MALTEPE	0	0	0	0	13	1,714	6	1,324	21	5,530
	18	KARTAL	0	0	1	145	2	448	17	2,542	20	3,135
	22	PENDİK	0	0	0	0	1	78	28	4,653	29	4,731
	28	TUZLA	0	0	0	0	0	0	10	3,959	11	4,998
	Sub-Total		4	261	8	678	34	4,788	66	13,664	120	23,621
Asian: Bosphoras	30	ÜSKÜDAR	4	204	20	972	18	1,177	12	1,429	54	3,783
	6	BEYKOZ	8	1,583	7	881	0	0	4	1,692	19	4,156
	29	ÜMRANİYE	0	0	0	0	0	0	14	4,561	14	4,561
	Sub-Total		12	1,787	27	1,854	18	1,177	30	7,682	87	12,500
Total/Average of Asian Side			16	2,048	35	2,532	52	5,965	96	21,345	207	36,121
Total of IMM			116	5,627	152	9,636	125	11,745	223	49,276	628	88,335

Source: The JICA Study Team

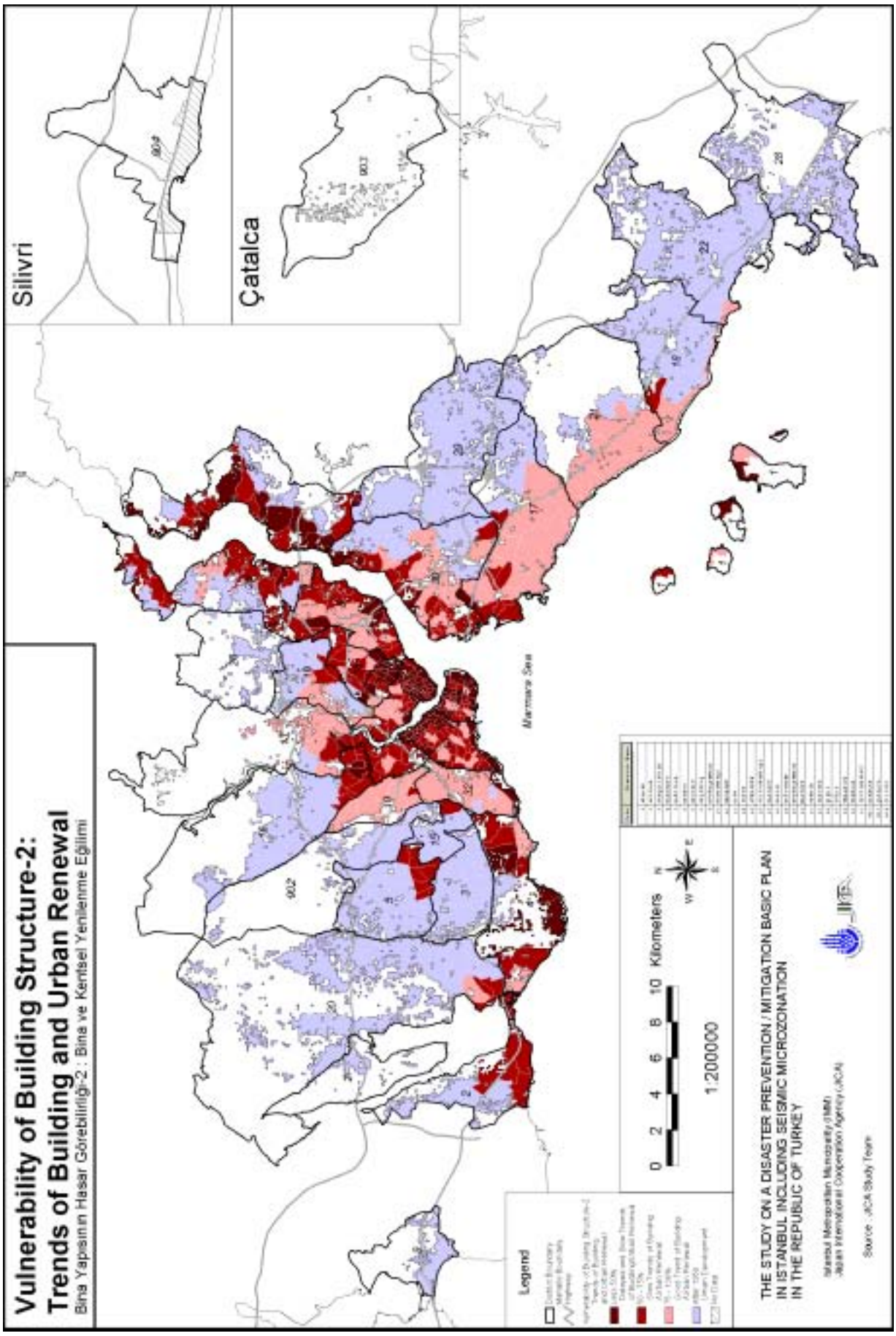


Figure 10.1.4 Building and Urban Renewal Trends

10.1.5. Excessive Land and Building Use: Rigid Urban Land Use

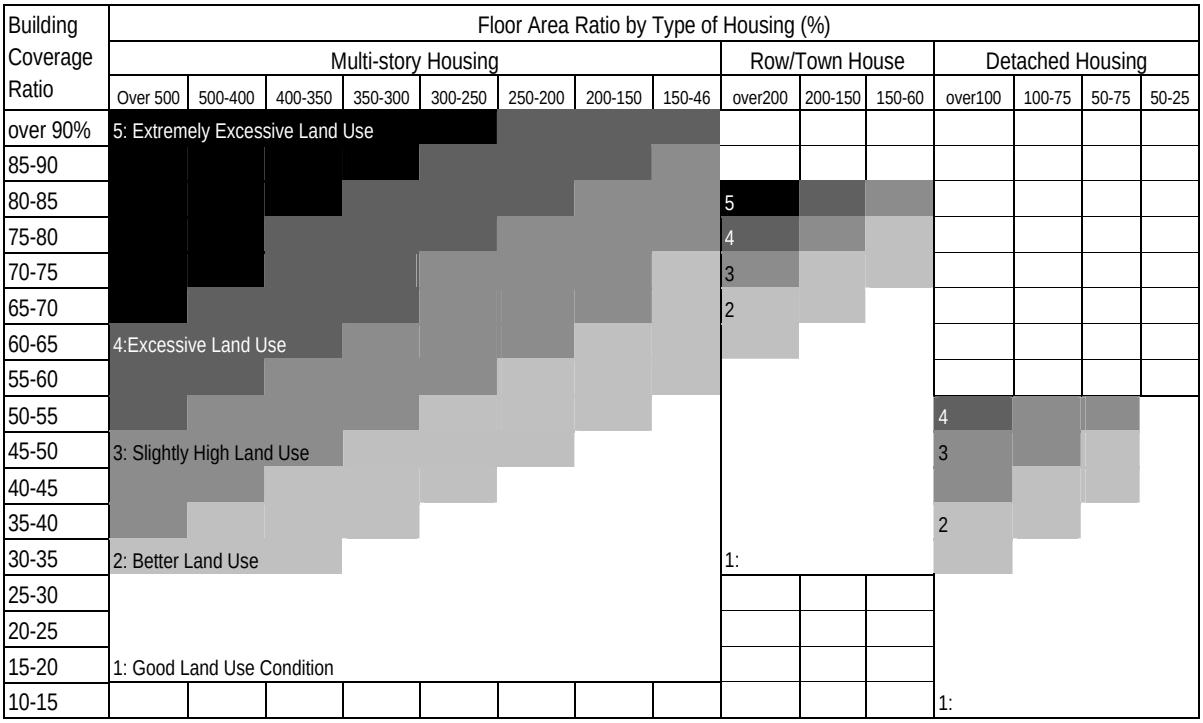
Excessive urban land utilization can exacerbate earthquake disaster damages as follows:

- **Evacuation routes blocked by collapsed buildings –can increase the number of human casualties:** the case of high ratios of building coverage development in an area.
- **Emergency roads blocked by collapsed buildings– can disturb emergency response operations:** the case of high ratios of building coverage development in an area. **A lack of evacuation areas for residents –can increase the number of human casualties:** the case of middle or high-rise building development without proper public and/or private open spaces.

For the analysis, building floor area ratio and building coverage area ratio are used to assess excessive land utilization conditions.

Net Floor Area Ratio is estimated by the JICA Study Team as total floor area, which is based on data of building coverage area, number of stories, and plot area data from the 2000 Building Census. *Building Coverage Area Ratio* is also estimated by the JICA Study Team based on the data of building coverage area and plot area from the results of the 2000 Building Census.

Evaluation criteria of excessive land use area with regards to type of building and housing are as follows:



Source: JICA Study Team

Based on the data and criteria, excessive land use mahalles are identified as follows:

- **Extremely high land use condition**: 102 mahalles (16% of total) and around 2,000 ha (4% of the urbanized area), which are concentrated on the European side of Istanbul's The Historic District, Marmara Coast and the Bosphorus Strait Area and Üsküdar on the Asian Side.
- **High land use condition**: 119 mahalles (19% of total) and around 4,300 ha (8% of the urbanized area), which are also concentrated in almost all districts on the European side, except Avcılar and Sarıyer, and the two districts of Kadıköy and Üsküdar on the Asian Side.
- **Slightly high land use condition**: 120 mahalles (19% of total) and around 9,700 ha (19% of the urbanized area), which are widely spread out over almost all districts, except the five districts of Bakırköy, Adalar, Kartal, Tuzla, and Çatalca.

Three districts in Istanbul's Historic District are seen to have the most crucial land-use issues to address in mitigating disaster damage, with 36%, 37%, and 13% of their urbanized areas categorized as having extremely high, high, and slightly high land uses, respectively.

Five districts on the European Marmara Coast also have serious urban land use conditions, where extremely high, high, and slightly high land use percentages of urbanized areas are 7%, 13%, and 19%, respectively.

Four districts in the European Bosphorus area have 12%, 10%, and 20% of their urbanized areas categorized as having extremely high, high, and slightly high land uses.

Six districts in the European inland area do not have urbanized areas categorized as having extremely high land use, but high and slightly high land use areas were observed with shares of 16% and 37%, respectively.

Six districts on the Asian Marmara Coast do not have extremely high land use, but limited high and slightly high land use areas were found.

In three districts in the Asian Bosphorus Area, most of the areas are assessed as not having serious urban land use issues, but the part of Üsküdar is categorized as having extremely high and high urban land use areas.

Three districts outside of the IMM do not have serious urban land use conditions.

Table 10.1.4 Excessive Land Use Status

Area	District		District Area (ha)		Extremely High		High		Slightly High		Total of High Land Use Mahalle				Other Mahalle	
	Code	Name	Total	Urban Area	No. of Mahalle	Urban Area(ha)	No. of Mahalle	Urban Area(ha)	No. of Mahalle	Urban Area(ha)	No. of Mahalle	share (%)	Urban Area(ha)	share (%)	Good Mahalle	Better Mahalle
Old Town	12	EMİNÖNÜ	508	453	18	199	8	100	3	30	29	88	329	73	3	1
	14	FATİH	1,045	982	27	382	28	392	9	121	64	93	895	91	2	3
	7	BEYOĞLU	889	828	21	225	14	341	6	152	41	91	718	87	3	1
	Sub-Total		2,443	2,263	66	806	50	833	18	303	134	91	1,942	86	8	5
Europe: Marmara Coast	32	ZEYTİNBURNU	1,149	939	4	121	3	188	3	391	10	77	701	75	1	2
	4	BAKIRKÖY	2,951	1,429	2	46	5	240	0	0	7	47	286	20	4	3
	15	CÜNGÖREN	718	677	1	95	3	137	3	130	7	64	362	53	1	3
	3	BAHÇELİEVLER	1,661	1,430	2	164	2	188	3	208	7	64	560	39	1	3
	2	AVCILAR	3,861	1,531	0	0	0	0	1	407	1	11	407	27	7	1
	Sub-Total		10,340	6,006	9	426	13	753	10	1,136	32	54	2,315	39	14	12
Europe: Bosphoras	8	BESİKTAŞ	1,811	1,517	4	70	2	74	2	135	8	35	279	18	9	6
	19	KAĞITANE	1,443	1,221	7	339	6	248	5	461	18	100	1,048	86	0	1
	26	ŞİŞLİ	3,543	1,476	11	352	7	281	6	393	24	86	1,026	69	1	3
	23	SARIYER	2,774	2,096	0	0	0	0	4	262	4	17	262	12	11	8
	Sub-Total		9,570	6,311	22	761	15	603	17	1,250	54	59	2,615	41	21	18
Europe: Inland	13	EYÜP	5,050	1,522	0	0	5	267	2	133	7	35	400	26	6	5
	16	GAZİOSMANPAŞA	5,676	2,458	0	0	2	140	18	1,541	20	69	1,681	68	5	3
	10	BAYRAMPAŞA	958	766	0	0	5	282	5	384	10	91	666	87	1	0
	902	ESENLER	3,890	1,022	0	0	10	541	4	157	14	78	698	68	4	0
	5	BAĞCILAR	2,194	1,939	0	0	9	531	8	599	17	77	1,130	58	1	4
	20	KÜÇÜKÇEKMECE	12,173	4,139	0	0	2	133	8	1,581	10	43	1,714	41	6	6
	Sub-Total		29,942	11,846	0	0	33	1,894	45	4,394	78	63	6,288	53	23	18
Total/Average of European Side			52,295	26,426	97	1,993	111	4,083	90	7,083	298	71	13,159	50	66	53
Asian: Marmara	1	ADALAR	1,100	376	0	0	0	0	0	0	0	0	0	0	5	1
	17	KADIKÖY	4,128	3,530	0	0	2	129	1	53	3	11	182	5	21	4
	21	MALTEPE	5,530	2,317	0	0	0	0	3	261	3	14	261	11	13	3
	18	KARTAL	3,135	2,619	0	0	0	0	0	0	0	0	0	0	18	2
	22	PENDİK	4,731	3,559	0	0	0	0	5	419	5	17	419	12	17	7
	28	TUZLA	4,998	1,980	0	0	0	0	0	0	0	0	0	0	9	1
	Sub-Total		23,621	14,381	0	0	2	129	9	733	11	9	862	6	83	18
Asian: Bosphoras	30	ÜSKÜDAR	3,783	3,299	5	42	6	105	10	416	21	39	563	17	24	9
	6	BEYKOZ	4,156	2,340	0	0	0	0	2	313	2	11	313	13	14	3
	29	ÜMRANİYE	4,561	3,600	0	0	0	0	4	849	4	29	849	24	9	1
	Sub-Total		12,500	9,239	5	42	6	105	16	1,578	27	31	1,725	19	47	13
Total/Average of Asian Side			36,121	23,619	5	42	8	234	25	2,311	38	18	2,587	11	130	31
Outside IMM	9	BÜYÜKÇEKMECE	1,474	446	0	0	0	0	3	273	3	50	273	61	2	0
	903	ÇATALCA	5,263	426	0	0	0	0	0	0	0	0	0	0	2	0
	904	SİLİVRİ	3,828	841	0	0	0	0	2	50	2	40	50	6	3	0
	Sub-Total		10,565	1,713	0	0	0	0	5	323	5	38	323	19	7	0
Total			98,981	51,759	102	2,035	119	4,318	120	9,717	341	53	16,069	31	203	84

Source: The JICA Study Team

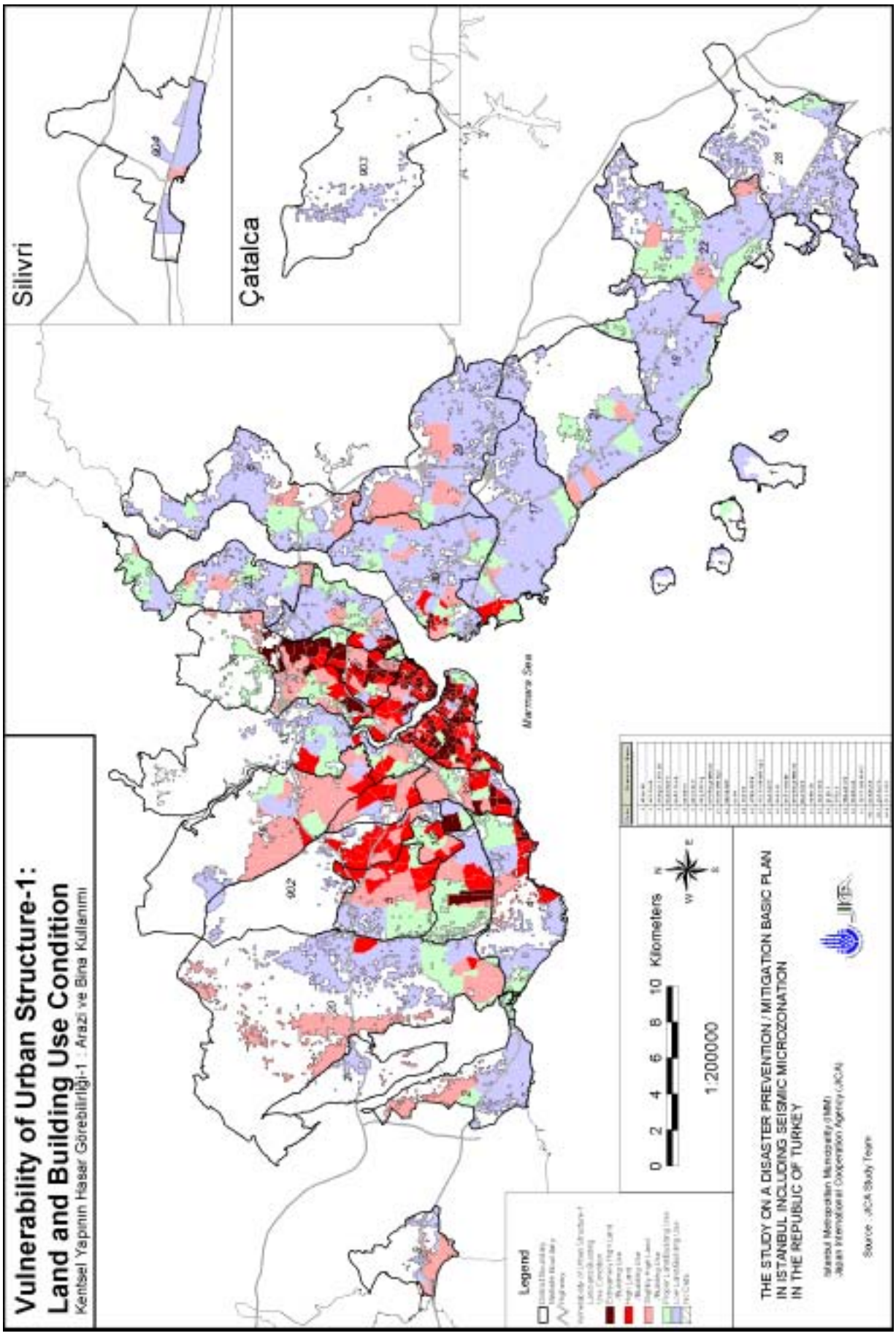


Figure 10.1.5 Land and Building Use Status by Mahalle

10.1.6. Road Density (m/ha) in Urbanized Areas

(1) Existing Road Conditions and Structures in Istanbul

The regional main road (highway) network is well developed, serving as the main road network structure of Istanbul in the last two decades. On the other hand, the hierarchical urban road network system, which is composed of urban arteries, collector roads, and access road networks, is not well developed and structured; it was constructed without proper planning and geometric design and brought about by illegal and irregular urban development trends after 1950.

4) Existing Condition of Hierarchical Road Structure

The existing condition of the road network in Istanbul can be thought of in upgrading stages towards the establishment of a hierarchical road system. Road length and share of urban arteries and collector roads are insufficient to support the socioeconomic activities of the metropolitan area. Also, narrow roads are part of regional roads, urban arteries, and collector roads and have been identified as follows:

- **Type 1 Regional Road:** the present length and share of regional roads are sufficient. However, the road width of two-thirds of the road length is inappropriately narrow (less than 6 m: 5%, 7 – 15m: 58%).
- **Type 2 Urban Artery:** the present road length, share, and width are insufficent, and narrow roads are inappropriately assuming major road functions.
- **Type 3 Collector Road:** the present road length, share, and width are also insufficient, and more than half of the road length is inappropriately narrow (less than 6 m in width).
- **Type 0 Access Road:** the present road length and share are very high. Some existing access roads will require upgrading to urban arteries and collector roads. However, the present road width condition could not be said to be really narrow.

Table 10.1.5 Share of Road Length by Width and Type of Road and Narrow Road Length and Share

Area	District		Total Road Length (km)	Type-1: Regional Road (1,109km 8%)				Type-2: Urban Artery (835km, 6%)				Type-3: Collector Road (908km, 7%)				Type-0: Access Road (10,848km, 79%)					All Narrow Road	
	Code	Name		2-6m	7-15m	Over 16m	NA	2-6m	7-15m	over 16m	NA	2-6m	7-15m	over 16m	NA	0-1m	2-6m	7-15m	over 16m	NA	Length (km)	share (%)
Old Town	12	EMINÖNÜ	118	0	23	77	0	34	66	0	0	76	24	0	0	0.0	78	14	1	7	72	61
	14	FATİH	268	3	30	67	0	6	94	0	0	72	27	1	0	0.0	87	12	0	0	196	73
	7	BEYOĞLU	241	8	46	47	0	44	56	0	0	75	25	0	0	0.4	86	13	0	1	178	74
	Sub-Total		627	5	36	59	0	27	73	0	0	73	26	1	0	0.1	85	13	0	2	446	71
Europe: Marmara Coast	32	ZEYTİNBURNU	235	2	57	41	0	2	93	6	0	14	82	4	0	0.0	66	29	0	5	113	48
	4	BAKIRKÖY	350	2	43	55	0	14	85	0	0	21	75	1	3	0.2	62	32	2	4	169	48
	15	CÜNGÖREN	186	10	66	24	0	0	100	0	0	19	80	0	0	0.0	44	55	0	1	67	36
	3	BAHÇELİEVLER	373	1	56	43	0	3	93	4	0	19	77	4	0	0.0	61	37	1	1	186	50
	2	AVCILAR	432	0	49	50	0	18	82	0	0	46	54	0	0	0.0	74	18	2	6	270	62
	Sub-Total		1,575	3	52	45	0	10	88	2	0	25	72	2	0	0.0	64	31	1	4	804	51
Europe: Bosphoras	8	BESİKTAŞ	326	1	60	39	0	6	94	0	0	37	63	0	0	0.0	65	30	1	4	166	51
	19	KAĞITANE	344	4	64	32	0	16	84	0	0	41	58	0	0	0.1	79	20	0	1	216	63
	26	ŞİŞLİ	475	2	51	46	1	27	60	13	0	38	59	3	0	0.0	72	24	0	4	301	63
	23	SARIYER	497	1	75	24	0	27	70	0	2	74	25	0	0	0.0	87	11	0	2	388	78
	Sub-Total		1,642	2	61	37	0	18	79	2	1	57	43	0	0	0.0	76	20	0	3	1,072	65
Europe: Inland	13	EYÜP	488	2	54	44	1	21	77	2	0	62	38	0	0	0.1	78	17	0	4	323	66
	16	GAZİOSMANPAŞA	862	7	38	50	5	19	81	0	0	45	55	0	0	0.1	81	18	0	1	609	71
	10	BAYRAMPAŞA	235	6	49	41	5	2	87	7	4	43	56	0	0	0.0	64	26	3	6	120	51
	902	ESENLER	517	0	55	41	4	13	87	0	0	66	31	0	2	0.0	84	14	0	2	395	76
	5	BAĞCILAR	562	0	74	26	0	14	86	0	0	37	63	0	0	0.0	74	22	0	4	345	61
	20	KÜÇÜKÇEKMECE	1,256	3	71	26	0	27	72	1	1	50	50	0	1	0.0	77	21	1	1	863	69
	Sub-Total		3,920	3	58	37	2	20	79	1	1	52	48	0	0	0.0	78	19	0	2	2,655	68
Total/Average of European Side			7,764	3	55	41	1	18	81	1	0	51	48	1	0	0.0	75	21	1	3	4,977	64
Asian: Marmara Coast	1	ADALAR	123													0.1	80	19	0	0	99	81
	17	KADIKÖY	733	8	60	32	0	19	76	5	0	22	76	1	0	0.0	67	31	0	2	395	54
	21	MALTEPE	740	5	59	36	0	18	82	0	0	17	83	0	0	0.0	70	28	0	1	464	63
	18	KARTAL	612	4	74	22	0	7	90	3	0	36	64	0	0	0.0	66	30	1	3	323	53
	22	PENDİK	741	16	71	12	0	30	64	6	0	79	21	0	0	0.0	87	11	1	1	562	76
	28	TUZLA	558	9	67	24	0	30	70	0	0	75	25	0	0	0.0	74	20	2	3	383	69
	Sub-Total		3,508	9	67	25	0	20	77	3	0	48	51	0	0	0.0	73	24	1	2	2,226	63
Asian: Bosphoras	30	ÜSKÜDAR	757	4	54	42	0	18	82	0	0	48	52	0	0	0.0	79	19	0	2	499	66
	6	BEYKOZ	556	18	50	16	16	65	35	0	0	69	31	0	0	0.2	85	12	0	3	429	77
	29	ÜMRANİYE	982	1	56	43	0	11	88	1	0	43	55	1	0	0.1	78	21	1	1	659	67
	Sub-Total		2,295	7	54	35	4	27	73	1	0	51	48	0	0	0.1	80	18	0	1	1,587	69
Total/Average of Asian Side			5,803	8	62	28	1	23	75	2	0	50	50	0	0	0.0	76	22	1	2	3,813	66
Outside IMM	9	BÜYÜKÇEKMECE	133	0	0	100	0									0.0	56	35	1	8	72	54
	903	ÇATALCA	NA																			
	904	SİLİVRİ	NA																			
	Sub-Total		133	0	0	100	0									0.0	56	35	1	8	72	54
Total			13,700	5	58	36	1	20	79	2	0	51	49	0	0	0.0	75	22	1	2	8,861	65

Source: Original GIS road network was provided by IMM. Road width data were included on the GIS base map of the IMM by the JICA Study Team.

(2) Road Density

In ordinary times, road networks with supporting infrastructure serve a very important function for all socioeconomic urban activities. During an urban disaster, appropriate road densities are required in order to operate proper emergency response activities and to provide evacuation routes for citizens.

The existing road density of urbanized areas was assessed and divided into 5 categories (*extremely low, low, slightly low, proper density*, and *sufficient density*) based on the GIS road network database for each mahalle and types of urban and building structures.

The results of the road density analysis were found not to be very critical as described below:

- **Extremely Low Density** (less than 50% of required road density): only 3 mahalles (0.5% of a total of 628 mahalles in the IMM) were categorized as such and are located in the Emınonu, Sarıyer, and Beyköz districts with 160 ha (0.3% of total urbanized area). The assessed mahalles of this category are almost negligible.
- **Low Density** (50 to 75% of required road density): 40 mahalles (6% of the total) in Eminonu, Beyoglu, Sarıyer, Eyüp, Gaziosmanpasa, Adalar, Pendik and 3 districts of the Asian Bosphorus area with 3,460 ha (7% of total urbanized area).
- **Slightly Low Density** (75 to 99% of required road density): 54 mahalles (8% of the total) widely distributed over 16 districts with 4,785 ha (9% of total urbanized area).
- **Proper Road Density** (100 to 125% of required road density): 52 mahalles (8% of the total).
- **Sufficient Road Density** (over 125% of required road density): 470 mahalles (75% of the total).

A total of 97 mahalles (15% of the total number of mahalles in the IMM) are assessed as having extremely low, low and slightly low road density with 8,400 ha (18% of the urbanized area in the IMM).

Table 10.1.6 Assessed Existing Road Density by Mahalle

Area	District		Extremely Low		Low		Slightly Low		Total of Low Road Density				Other Mahalle	
	Code	Name	Mahalle	Urbanized area	Mahalle	Urbanized area	Mahalle	Urbanized area	Mahalle	Share in district	Urbanized area	Share in district	Proper Density	Enough Density
Old Town	12	EMİNÖNÜ	1	64	8	127	0	0	9	27	191	42	1	20
	14	FATİH	0	0	0	0	3	41	3	4	41	4	7	59
	7	BEYOĞLU	0	0	1	44	2	48	3	7	91	11	1	41
	Sub-Total		1	64	9	171	5	89	15	10	324	14	9	120
Europe: Marmara Coast	32	ZEYTİNBURNU	0	0	0	0	1	262	1	8	262	28	0	12
	4	BAKIRKÖY	0	0	0	0	1	64	1	7	64	4	3	11
	15	CÜNGÖREN	0	0	0	0	0	0	0	0	0	0	1	10
	3	BAHÇELİEVLER	0	0	0	0	0	0	0	0	0	0	1	10
	2	AVCILAR	0	0	0	0	0	0	0	0	0	0	1	8
	Sub-Total		0	0	0	0	2	326	2	3	326	5	6	51
Europe: Bosphoras	8	BESİKTAŞ	0	0	0	0	0	0	0	0	0	0	2	21
	19	KAĞITANE	0	0	0	0	0	0	0	0	0	0	1	18
	26	ŞİŞLİ	0	0	0	0	0	0	0	0	0	0	8	20
	23	SARIYER	1	10	2	158	10	620	13	57	788	38	0	10
	Sub-Total		1	10	2	158	10	620	13	14	788	12	11	69
Europe: Inland	13	EYÜP	0	0	7	649	5	370	12	60	1,018	67	0	6
	16	GAZİOSMANPAŞA	0	0	1	175	5	323	6	21	498	20	2	20
	10	BAYRAMPAŞA	0	0	0	0	0	0	0	0	0	0	0	11
	902	ESENLER	0	0	0	0	2	76	2	11	76	7	0	16
	5	BAĞCILAR	0	0	0	0	0	0	0	0	0	0	1	21
	20	KÜÇÜKÇEKMECE	0	0	0	0	1	343	1	4	343	8	3	18
	Sub-Total		0	0	8	824	13	1,112	21	17	1,935	16	6	92
Total/Average of European Side			2	75	19	1,152	30	2,147	51	12	3,373	13	32	332
Asian: Marmara	1	ADALAR	0	0	1	99	3	220	4	36	318	85	0	2
	17	KADIKÖY	0	0	0	0	4	374	4	14	374	11	5	19
	21	MALTEPE	0	0	0	0	2	175	2	10	175	8	1	16
	18	KARTAL	0	0	0	0	0	0	0	0	0	0	0	20
	22	PENDİK	0	0	7	992	4	617	11	38	1,610	45	4	14
	28	TUZLA	0	0	0	0	0	0	0	0	0	0	2	8
	Sub-Total		0	0	8	1,091	13	1,386	21	18	2,477	17	12	79
Asian: Bosphoras	30	ÜSKÜDAR	0	0	2	106	6	537	8	15	643	19	3	43
	6	BEYKOZ	1	86	10	1,006	4	592	15	79	1,684	72	1	3
	29	ÜMRANİYE	0	0	1	105	1	124	2	14	229	6	3	9
	Sub-Total		1	86	13	1,217	11	1,253	25	29	2,556	28	7	55
Total/Average of Asian Side			1	86	21	2,308	24	2,639	46	22	5,032	21	19	134
Total			3	160	40	3,460	54	4,785	97	15	8,406	18	51	466
		share (%)	0.5	0.3	6.2	6.9	8.6	9.6					8.3	74.8

Source: The JICA Study Team

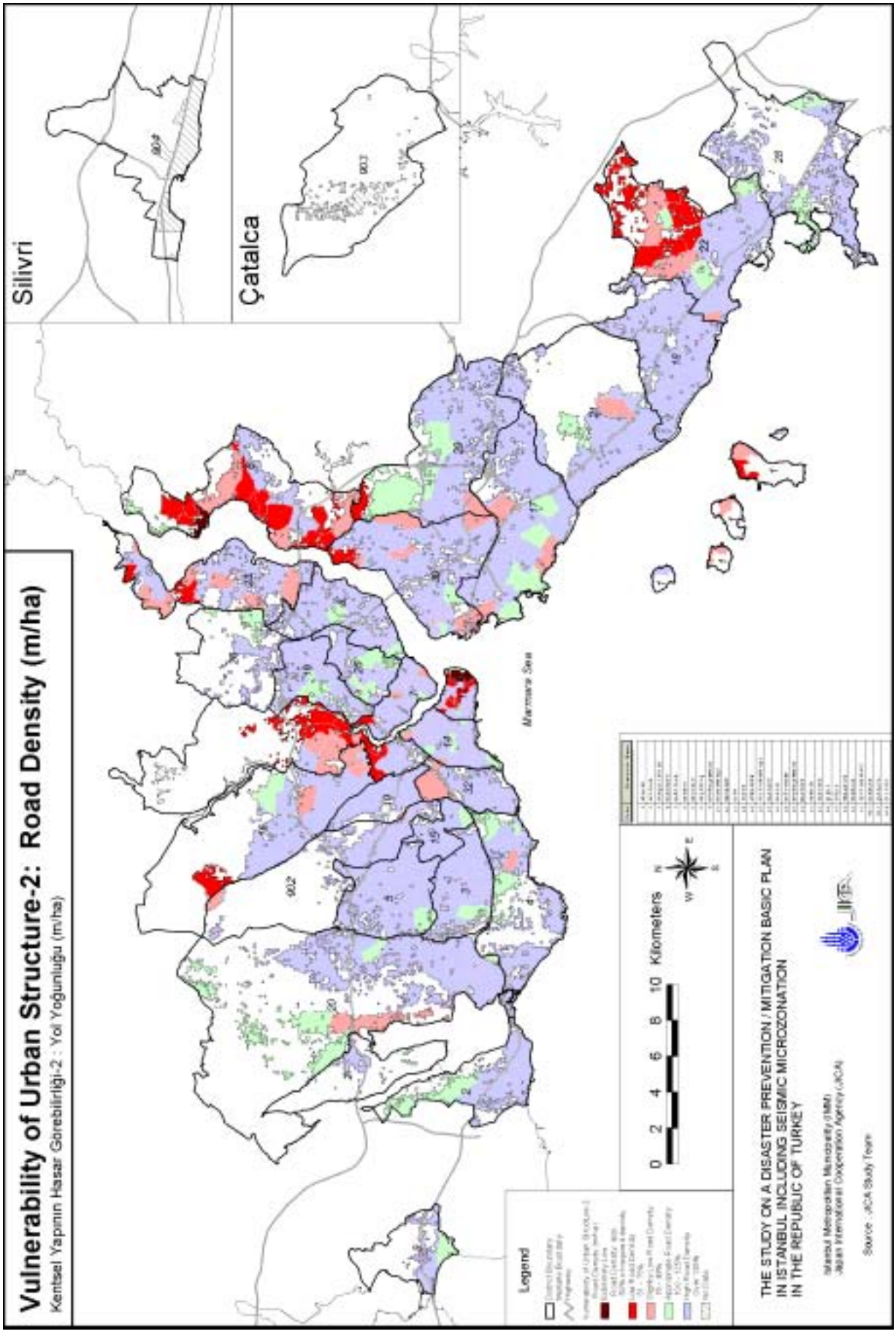


Figure 10.1.6 Road Density (m/ha)

10.1.7. Narrow and Inappropriate Road Conditions: Constraints for Evacuation and Emergency Response Operations

Safety issues related to existing road conditions were identified by taking into account the existence of narrow roads during an urban earthquake disaster. Narrow roads will be serious constraints for the safe evacuation of citizens and proper emergency vehicle operations as follows:

1) Narrow roads - less than 4 m wide

Even during normal times, roads less than 4 m wide cannot be properly used by emergency vehicles due to the following reasons:

- Improper geometric road design for vehicle operation (especially in the Histric District areas); and
- Street parking that blocks emergency vehicular traffic.

Furthermore, in the case of an earthquake disaster, debris of collapsed and heavily damaged buildings along the street will cover and close more than 3 m of road width.

2) Narrow roads - 4 to 6 m wide

Under an earthquake disaster, roads less than 6 m wide will be closed and will not be used as routes of emergency vehicle or evacuation operations or .

Areas assessed as having high building damage and high narrow road ratios will be isolated, and eventually suffer damage of catastrophic proportions, if no rescue and other emergency response operation are undertaken.

There are 8,785 km (65% of 13,567 km of total road length) of narrow roads 2 to 6m wide or less in Istanbul. The narrow road ratio analysis by mahalle is categorized into 5 groups as follows:

- **Over 80%** of road length is made up of narrow roads: 149 mahalles (23% of the total), or 9,385 ha (19% of the total) of the urbanized area, will have high potential to be isolated based on building damage conditions. The categorized mahalles are widely spread out except on the European Marmara Coast and in Besiktas and Kadıköy.
- The categorized mahalles are widely spread out except on the European Marmara Coast and in Besiktas and Kadıköy.

- **61 – 80%:** 247 mahalles (38%) and 19,294 ha (38%) of the urbanized area will also have a potential to be isolated. The categorized 247 mahalles are more widely distributed in almost all of districts, except the district of Güngören.
- **41 – 60%:** 179 mahalles (28%) and 16,610 ha (33%) of the urbanized area will have evacuation activities and emergency vehicle operations disrupted, parts of the mahalles will be isolated due to closed roads. Thiscategory of mahalles are also widely spread out over all districts.
- **21 – 40%:** 50 mahalles (8%) and 4,657 ha (9%) of the urbanized area will not have evacuation and emergency vehicle operations free to navigate the roads, but substitute access routes were identified. This category of mahalles is limitedly distributed in the districts with better road conditions.
- **0-20%:** 0nly 10 mahalles (2%) and 731 ha of the urbanized area will have evacuation and emergency operation activities disrupted by road closures. These mahalles are mainly located in the districts on the European Marmara Coast.

Table 10.1.7 Narrow Road Ratio by Mahalle

Area	District		Total Length (km)	Over 80%		61-80%		41-60%		21-40%		0-20%		Narrow Road	
	Code	Name		Mahalle	Urbanized area (ha)	Mahalle	Urbanized area (ha)	Mahalle	Urbanized area (ha)	Mahalle	Urbanized area (ha)	Mahalle	Urbanized area (ha)	Length (km)	Ratio (%)
Old Town	12	EMİNÖNÜ	118	8	63	14	178	8	133	2	71	1	7	72	61
	14	FATİH	268	27	340	24	377	14	223	4	41	0	0	196	73
	7	BEYOĞLU	241	20	345	16	274	7	190	2	19	0	0	178	74
	Sub-Total		627	55	749	54	829	29	547	8	132	1	7	445	71
Europe: Marmara Coast	32	ZEYTİNBURNU	235	0	0	3	183	7	320	2	353	1	83	113	48
	4	BAKIRKÖY	350	0	0	5	318	7	963	2	268	1	64	169	48
	15	CÜNGÖREN	186	0	0	0	0	4	322	4	199	3	156	67	36
	3	BAHÇELİEVLER	373	0	0	4	281	5	578	1	286	1	285	186	50
	2	AVCILAR	432	1	407	3	355	4	686	1	83	0	0	270	62
	Sub-Total		1,575	1	407	15	1,137	27	2,871	10	1,189	6	587	803	51
Europe: Bosphoras	8	BESİKTAŞ	326	0	0	9	455	9	604	5	459	0	0	166	51
	19	KAĞITANE	344	3	101	9	411	7	710	0	0	0	0	216	63
	26	ŞİŞLİ	475	5	372	11	449	6	353	6	303	0	0	301	63
	23	SARIYER	497	10	1,034	12	1,052	0	0	0	0	1	10	388	78
	Sub-Total		1,642	18	1,506	41	2,367	22	1,667	11	761	1	10	1,071	65
Europe: Inland	13	EYÜP	488	3	91	10	650	7	781	0	0	0	0	323	66
	16	GAZİOSMANPAŞA	862	7	526	13	1,081	8	824	0	0	1	27	609	71
	10	BAYRAMPAŞA	235	1	23	3	211	4	300	2	132	1	100	120	51
	902	ESENLER	517	7	302	9	663	2	57	0	0	0	0	395	76
	5	BAĞCILAR	562	1	62	13	987	7	568	1	322	0	0	345	61
	20	KÜÇÜKÇEKMECE	1,256	5	1,111	9	1,284	7	1,636	2	108	0	0	863	69
	Sub-Total		3,920	24	2,116	57	4,874	35	4,166	5	563	2	127	2,654	68
Total/Average of European Side			7,764	98	4,778	167	9,207	113	9,251	34	2,645	10	731	4,974	64
Asian: Marmara Coast	1	ADALAR	123	6	227	4	148	1	0	0	0	0	0	99	80
	17	KADIKÖY	733	0	0	9	980	13	1,709	6	841	0	0	395	54
	21	MALTEPE	740	4	542	4	222	10	1,083	3	470	0	0	464	63
	18	KARTAL	612	1	89	3	611	12	1,471	4	447	0	0	323	53
	22	PENDİK	741	12	1,575	11	1,245	6	738	0	0	0	0	562	76
	28	TUZLA	558	2	144	7	1,499	2	337	0	0	0	0	383	69
	Sub-Total		3,508	25	2,578	38	4,705	44	5,339	13	1,758	0	0	2,226	63
Asian: Bosphoras	30	ÜSKÜDAR	757	14	524	26	1,657	11	864	3	254	0	0	499	66
	6	BEYKOZ	556	11	1,222	6	906	2	211	0	0	0	0	428	77
	29	ÜMRANİYE	982	1	284	9	2,750	4	566	0	0	0	0	659	67
	Sub-Total		2,295	26	2,030	41	5,313	17	1,642	3	254	0	0	1,586	69
Total/Average of Asian Side			5,803	51	4,608	79	10,019	61	6,981	16	2,012	0	0	3,811	66
Outside IMM	9	BÜYÜKÇEKMECE	133	0	0	1	69	5	378	0	0	0	0	72	54
	903	ÇATALCA	NA	0	0	0	0	0	0	0	0	0	0	NA	NA
	904	SİLİVRİ	NA	0	0	0	0	0	0	0	0	0	0	NA	NA
	Sub-Total		NA	0	0	1	69	5	378	0	0	0	0	NA	NA
Total			13,567	149	9,385	247	19,294	179	16,610	50	4,657	10	731	8,785	65
		Share (%)		23	19	38	38	28	33	8	9	2	1		

Source: The JICA Study Team

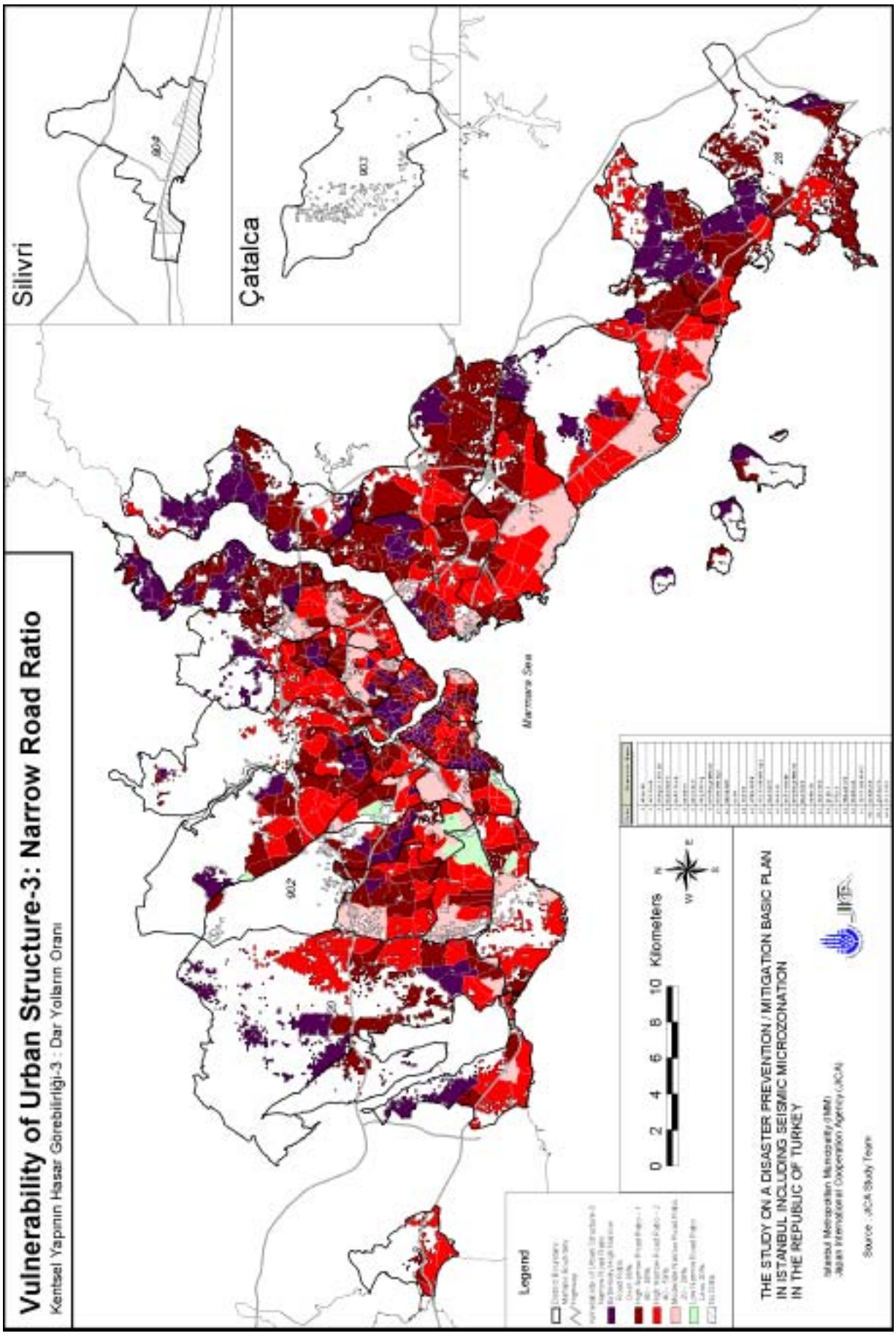


Figure 10.1.7 Narrow Road Ratio

10.1.8. Parks and Open Space Availability for Primary Safety Evacuation of Residents

Presently, an evacuation system has not been introduced or established in Turkey yet. On the other hand, the Tent Village System, which is an organized system of 486 small (less than 500m^2) to bigger sized designated tent villages, has been planned and established in Istanbul.

To keep citizens safe, a new urban disaster emergency evacuation system is recommended for several reasons:

- To minimize human casualties from aftershocks,
- To minimize human casualties from secondary disasters, and
- To collect accurate primary damage information from evacuated residents for arrangement of appropriate response operation teams and emergency goods, etc.

The recommended evacuation system is made up community and regional evacuation areas, accessed by evacuation routes as follows:

1) Primary Evacuation Areas:

Primary evacuation and gathering places are not only recommended to focus on the safety of citizens but also to collect accurate primary damage information faster from the evacuated residents by the recommended self-organized community disaster task forces. This information will be most useful to organize and dispatch emergency task forces even without any instructions from the disaster management centre.

The evacuation areas are recommended to be located in each neighborhood unit and s d f are intended for all residents and citizens (gross minimum area: 1.5 m^2/person). Evacuation areas should be selected and designated from publicly-owned lands or facilities as follows:

- **Candidates:** parks, open spaces, schools, and religious facilities, which are most commonly and evenly distributed in each neighborhood community unit.
- **Seismically Resistant Building Structures**: at present, public schools and mosques are well distributed in neighborhood units, but the building structures of these facilities were not found to be sufficiently seismically resistant, except for some newly constructed schools.

- **Open Spaces:** parks and open spaces with areas bigger than 2000 m^2 (minimum 500 m^2) are the most appropriate candidates for primary evacuation areas in Istanbul.
- **Other Hazards:** unstable and steep slope areas (prone to landslide disasters) and the areas adjacent to hazardous facilities such as LPG/fuel stations, etc. (prone to secondary disasters of fire and explosion), and areas affected by building collapses.

2) Regional Evacuation Areas:

Regional evacuation areas can be thought of as undertaking almost the same functions as tent villages for victims in Istanbul. The Japanese standard of area distribution per victim is less than 5 m^2. However, the standard in Turkey is 9 to 10 m^2 per victim, which will require huge areas of tent villages in Istanbul.

3) Evacuation Routes:

It is also strongly recommended that evacuation routes for the safe evacuation of citizens be designated before a disaster.

In the analysis, land availability and shortage of parks and open spaces are assessed, along with the estimated demand of primary evacuation areas for all residents in each mahalle. Land availability of parks/open spaces for primary evacuation areas can be one indication of whether it would be safe or unsafe for mahalle residents in the event of an earthquake disaster.

The source database for the analysis of parks and open spaces was a survey developed by Ms. Aksoy[2] in cooperation with the Mapping and Research Directorate of the IMM. Then, the JICA Study Team proceeded with the update and establishment of the GIS Database of Parks and Open Spaces.

The result of the land availability analysis is categorized into 5 groups as follows:

[2] Aksoy, Y., (2001) The Determination of Existing Green Area Situation in Istanbul, Ph.D. Thesis, I.T.U., Institute of Science and Technology, Urban and Regional Planning Department, Landscape Planning Programme, 2001, Istanbul, Turkey.

- **Less than 25% of Demand:** The almost lack of parks/open spaces for primary evacuation areas was identified in 340 mahalles (53% of all mahalles). This category of mahalles were widely identified in 27 districts. Districts with a high number of these mahalles are Fatih, Beyoglü, Zeytinburunu, Güngören, Kagıtane, Sisli, Gaziosmanpasa, Esenler, Bagcılar, Küçükçekmece, Kadıköy, Maltepe, Kartal, Pendik, Umraniye, Çatalca, and Silivri.
- **25 to 49% of Demand:** 79 mahalles (12% of all mahalles) were found to have a limited number of parks and open spaces for primary evacuation areas. In the six districts of Bahçelievler, Avcılar, Kagıtane, Eyüp, Bayranpasa, and Ümraniye, this category of mahalles make up more than 20% of all mahalles.
- **50 to 99% of Demand:** 68 mahalles (11% of all mahalles) were found to have a shortage of parks and open spaces for primary evacuation areas.
- **100 to 150% of Demand:** 23 mahalles (4% of all mahalles) were found to have sufficient existing parks and open spaces for the demand of primary evacuation areas. However, net usable land for primary evacuation areas should be carefully examined considering the surrounding conditions in the district disaster management plan study.
- **Over 150% of Demand:** Existing areas of parks and open spaces were found to make up over 1.5 times of the area demand in 115 mahalles (18% of all mahalles). Also, it is recommended that net usable land should be examined in the district disaster management study.

Based on the above analysis, parks and open spaces had not been well developed and standardized in past urban developments, which may be due to squatter settlements and irregular housing developments in Istanbul. A total of 485 mahalles (76% of all mahalles) are categorized as *inappropriate mahalles*, capable of providing evacuation areas for residents. On the other hand, the present mahalles are not recognized as a standardized community unit. A primary evacuation area should be established at the recommended self-organized community disaster task force level, for which the district disaster management plan formulation study is also recommended to be considered in detail.

Also, road islands, medians, and roadside slopes are currently categorized as parks by the Parks Department of the IMM. However, these areas function as road landscaping areas and not as parks and open spaces.

Table 10.1.8 Availability of Parks and Open Spaces for Required Primary Evacuation Areas by Mahalle

Area	District		less 25%		25 - 49%		50 - 99%		100 - 150%		over 150%		Unknown	Total
	Code	Name	mahalle	(%)	mahalle	(%)	mahalle	(%)	mahalle	(%)	mahalle	(%)	mahalle	mahalle
Old Town	12	EMİNÖNÜ	13	39	2	6	2	6	1	3	15	45	0	33
	14	FATİH	43	62	5	7	5	7	3	4	13	19	0	69
	7	BEYOĞLU	31	69	0	0	4	9	2	4	8	18	0	45
	Sub-Total		87	59	7	5	11	7	6	4	36	24	0	147
Europe: Marmara Coast	32	ZEYTİNBURNU	7	54	2	15	3	23	0	0	1	8	0	13
	4	BAKIRKÖY	1	7	2	13	3	20	1	7	8	53	0	15
	15	CÜNGÖREN	8	73	2	18	1	9	0	0	0	0	0	11
	3	BAHÇELİEVLER	5	45	3	27	3	27	0	0	0	0	0	11
	2	AVCILAR	4	44	2	22	0	0	0	0	3	33	0	9
	Sub-Total		25	42	11	19	10	17	1	2	12	20	0	59
Europe: Bosphoras	8	BESİKTAŞ	5	22	2	9	3	13	3	13	10	43	0	23
	19	KAĞITANE	11	58	5	26	1	5	1	5	1	5	0	19
	26	ŞİŞLİ	21	75	2	7	2	7	0	0	3	11	0	28
	23	SARIYER	9	39	4	17	5	22	2	9	3	13	0	23
	Sub-Total		46	49	13	14	11	12	6	6	17	18	0	93
Europe: Inland	13	EYÜP	5	25	4	20	4	20	0	0	7	35	0	20
	16	GAZİOSMANPAŞA	22	76	5	17	0	0	0	0	1	3	1	29
	10	BAYRAMPAŞA	1	9	5	45	3	27	0	0	2	18	0	11
	902	ESENLER	14	78	1	6	1	6	1	6	0	0	1	18
	5	BAĞCILAR	17	77	4	18	1	5	0	0	0	0	0	22
	20	KÜÇÜKÇEKMECE	19	83	2	9	1	4	0	0	1	4	0	23
	Sub-Total		78	63	21	17	10	8	1	1	11	9	2	123
Total/Average of European Side			236	56	52	12	42	10	14	3	76	18	2	422
Asian: Marmara	1	ADALAR	0	0	1	9	1	9	1	9	2	18	6	11
	17	KADIKÖY	18	64	3	11	1	4	0	0	6	21	0	28
	21	MALTEPE	14	67	2	10	0	0	0	0	3	14	2	21
	18	KARTAL	12	60	3	15	4	20	0	0	1	5	0	20
	22	PENDİK	16	55	5	17	3	10	1	3	4	14	0	29
	28	TUZLA	2	18	1	9	3	27	4	36	0	0	1	11
	Sub-Total		62	52	15	13	12	10	6	5	16	13	9	120
Asian: Bosphoras	30	ÜSKÜDAR	19	35	9	17	9	17	3	6	14	26	0	54
	6	BEYKOZ	7	37	0	0	4	21	0	0	8	42	0	19
	29	ÜMRANİYE	9	64	3	21	1	7	0	0	1	7	0	14
	Sub-Total		35	40	12	14	14	16	3	3	23	26	0	87
Total/Average of Asian Side			97	47	27	13	26	13	9	4	39	19	9	207
Outside IMM	9	BÜYÜKÇEKMECE	0	0	0	0	0	0	0	0	0	0	6	6
	903	ÇATALCA	2	100	0	0	0	0	0	0	0	0	0	2
	904	SİLİVRİ	5	100	0	0	0	0	0	0	0	0	0	5
	Sub-Total		7	54	0	0	0	0	0	0	0	0	6	13
Total			340	53	79	12	68	11	23	4	115	18	17	642

Remark: Percentages in the head of columns show the ratio of land availability of parks and open spaces (bigger than 500 m2) in each mahalle (= park/open space area ÷ area demand for primary evacuation).

Source: The JICA Study Team

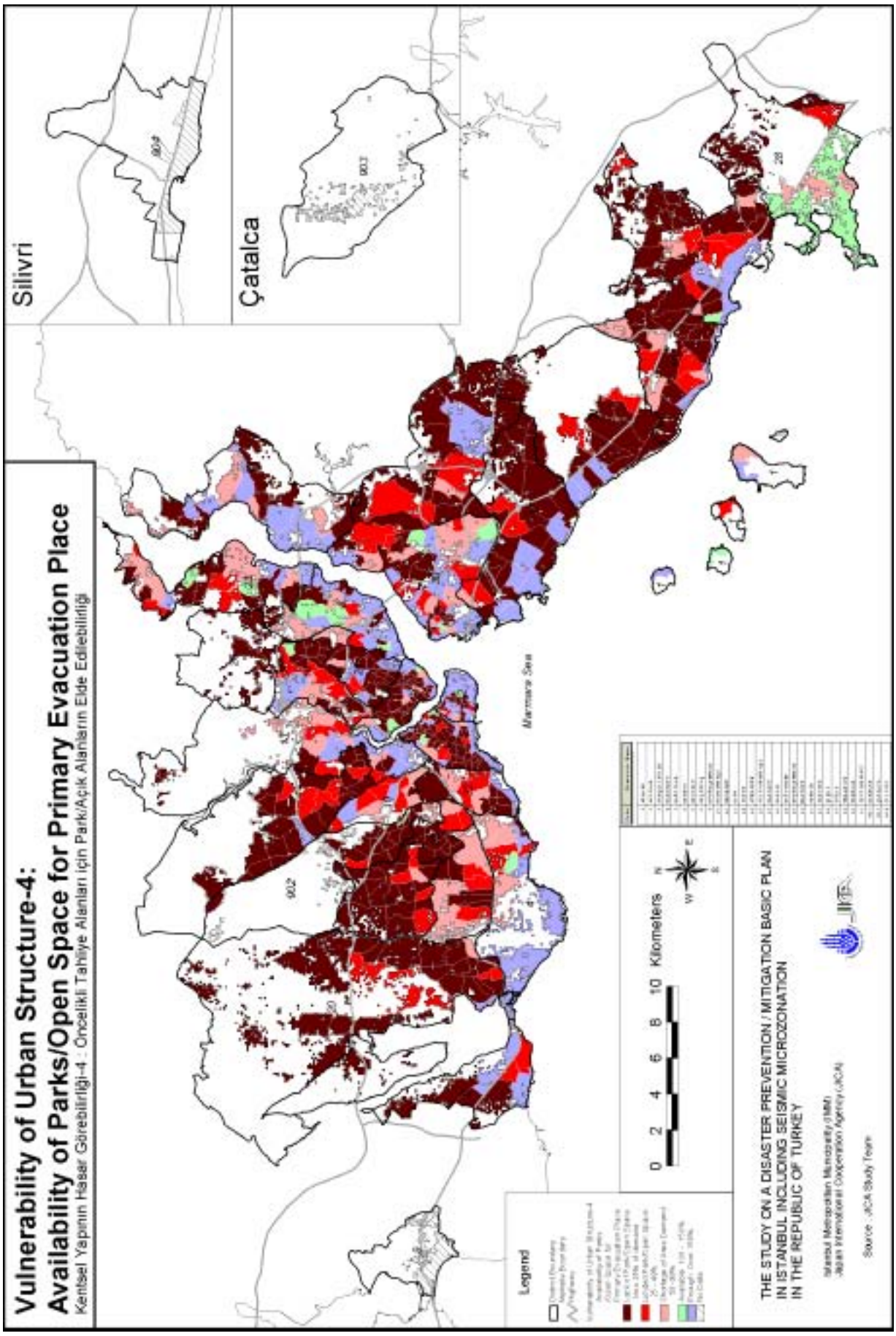


Figure 10.1.8 Availability of Parks/Open Spaces for Primary Evacuation Areas