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How Shall Tokyo Be Reconstructed after the Next Big Earthquake?:

The 1995 Great Hanshin-Awaji Earthquake and Tokyo's Preparedness Plan for Urban Reconstruction

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Abstract

In this paper, the author presents how Tokyo shall be reconstructed after the next big earthquake through the introduction of Tokyo's Urban Reconstruction Planning Manual. This manual was published in 1997 by Tokyo Metropolitan Government, learned from the Great Hanshin-Awaji Earthquake Disaster and the implementation of its urban reconstruction projects which were not easy to do in the severe condition of damaged areas. The purpose of this manual is to prepare the urban reconstruction plan making that will be implemented after a disaster in the remaining time an earthquake arrives. The contents of this paper are as follows;

1. The Urban Structure of Tokyo through Area Vulnerability Assessment.
2. Tokyo's Seismological Environment and the Next Big Earthquake.
3. Damage Estimation of the Next Big Earthquake in Tokyo.
4. Tokyo's Urban Planning and Promotional Plan for Disaster-resistant City.
5. Concept of the Next Reconstruction Plan and Plan-making Manual.
6. Conclusions.

As a result, the author concluded that, even if the preparedness plan for urban recovery and reconstruction such as Ground Design for Tokyo's Reconstruction can be developed, the most important countermeasure against the next Big One is a promotion and progression of the earthquake-proofing projects for making Tokyo a disaster-resistant city, improving community safer, and retrofitting existing houses without recent earthquake-resistant standard. Because the preparedness measures for recovery and reconstruction cannot reduce damages caused by the next Big Earthquake.

Preface

Tokyo has learned much from devastating earthquakes: the Great Kanto Earthquake (1923), the Niigata Earthquake (1964), the Northridge Earthquake (1994) and the Great Hanshin-Awaji Earthquake (1995). The Great Kanto Earthquake and major fires have taught Tokyo the importance of fireproofing

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and the need to construct urban structural firebreaks. The Niigata Earthquake warned of the vulnerability to earthquakes of the modern Japanese cities that grew rapidly in the postwar period of high economic growth, and prompted the Tokyo Metropolitan Government to initiate earthquake disaster prevention policies. The Great Hanshin-Awaji Earthquake raised many issues, such as how to promote the creation of a disaster-resistant city, how to make crowded wooden housing districts less vulnerable to earthquakes, and how to implement urban reconstruction projects smoothly after the next big earthquake.

In this paper, the author deals with the conceptual study on the relationship between a) urban improvement projects to create an earthquake-resistant city in the period before civil disaster and b) the reconstruction planning and reconstruction projects for the period after the next big earthquake hits Tokyo.

1. The Urban Structure of Tokyo through Area Vulnerability Assessment

Since 1923, Tokyo has been spared from earthquake devastation, and has not experienced severe damage since the bombing of 1945. After World War II, Tokyo grew rapidly. The capital created large built-up areas—many of them urban sprawls—not only in the suburbs but also in the central part of Tokyo. Today, Greater Tokyo spreads out in a 25 km radius, extending beyond the prefectural boundary of Tokyo.

The characteristics and degree of vulnerability differ from area to area. There is a question: which part of Tokyo is the most vulnerable to a strong earthquake? Based on the Tokyo Metropolitan Earthquake Disaster Prevention Ordinance (1971), earthquake risk (area vulnerability) assessments were implemented in 1975, 1984, 1993 and 1998. Area vulnerability consists of indices for four categories: 1) building collapse risk, 2) fire risk, 3) human risk (potential for death/injury as a result of the tremor) and 4) evacuation risk. Building collapse risk and fire risk indicate the potential for damage in the building environment of each area. According to the combined map of building collapse and fire risk, the high risk areas are distributed in the inner areas around the CBD of Tokyo that spreads from the JR Yamanote-sen (the Japan Railway Co. Ltd.'s Yamanote Railway loop line in the heart of Tokyo) out towards the 7th Loop Road (the most congested yet the most important in Tokyo). Other high-risk areas spread toward the west along the JR Chuo-sen (Central Line) (see Fig.1).

These high-risk areas are characterized by large numbers of small wooden houses crowded along very narrow roads and alleyways. These areas grew in an unplanned manner with the implementation of the Capital Reconstruction Project in central Tokyo after the Great Kanto Earthquake of 1923. Large parts of these sprawls were burnt down by the bombings in World War II, but were rebuilt—again, without any urban planning. Since the 1920s, these areas have been neglected due to the shortage of funding for urban planning projects.

2. Tokyo's Seismological Environment and the Next Big Earthquake

Japan is one of the most seismically active areas on Earth because it lies in the middle of a zone of convergence of four tectonic plates. The southern Kanto Region (Tokyo, Kanagawa, Chiba, Saitama and Ibaraki prefectures) is the most seismically active area, sitting on top of a complex plate structure.

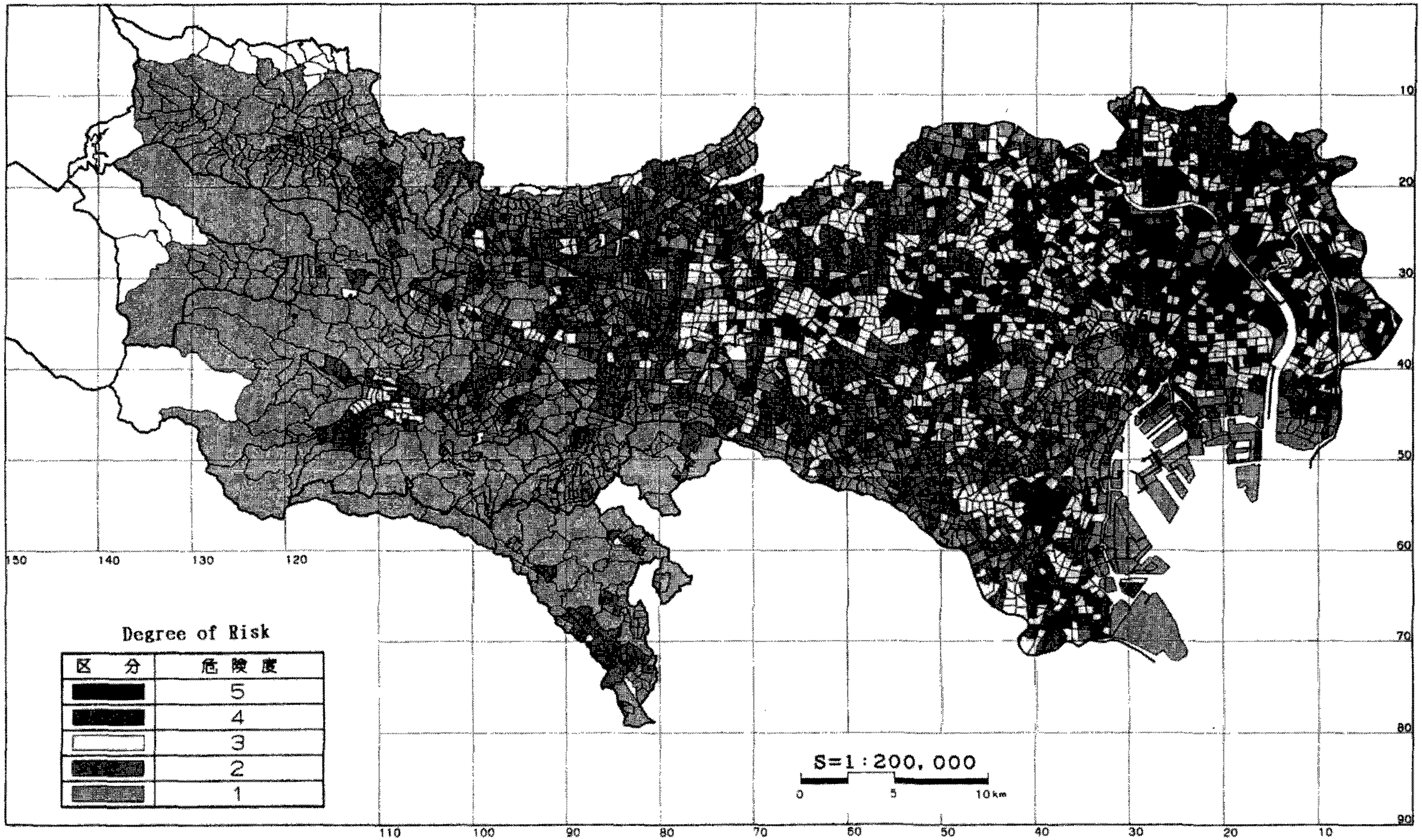


Fig.1 Area Vulnerability; Building Collapse and Fire Risk (The 4th Version, 1998)

Tokyo's seismological environment is as follows. The southern Kanto Region lies on the North American (continental) Plate. The Pacific Plate, which is the most active one, moves from east to west at a rate of 6 to 8 centimeters a year, and slides not only under the North American Plate at the Japan Trench but also under the Philippine Sea Plate at the Ogasawara Trench. The Philippine Sea Plate, on the other hand, is moving at the rate of 3 to 4 centimeters a year beneath the Kanto Region from south to north at the Sagami Trough, which lies off the shores of Kanagawa and Chiba.

The earthquakes that have caused significant damage to Tokyo can be classified roughly into two categories. The first one is the massive offshore earthquake with foci along the Sagami Trough. This can be as strong as Magnitude 8. The 1923 Great Kanto Earthquake was a typical example, having its epicenter on the west side of the Sagami Trough. The second kind of earthquake has its foci directly beneath the land, and is called an "inland earthquake" and can be as strong as Magnitude 7. If such an inland earthquake were to occur beneath an urban area, the damage would be great despite the limited area affected due to the crowded conditions. The 1948 Fukui Earthquake and the 1995 Great Hanshin-Awaji Earthquake fall into this category, as does the 1855 Ansei-Edo Earthquake that shook what is now Tokyo (then Edo).

In general, the movement of the tectonic plates beneath the Tokyo metropolitan region is extremely complex. It is thought that massive offshore earthquakes will occur within the next 100 to 200 years, however inland earthquakes may occur several times before then. Such an inland earthquake may be the next Big One to hit Tokyo.

3. Damage Estimation of the Next Big Earthquake in Tokyo

In 1991, Tokyo Metropolitan Government published a report entitled "A Survey of the Predicted Damage to Tokyo Caused by an Earthquake," that assumed a massive offshore earthquake of similar magnitude to the Great Kanto Earthquake. In 1988, the Central Disaster Prevention Council pointed out that the occurrence of an inland earthquake with a focus directly beneath the Southern Kanto Region might be imminent. In 1992 the Council announced a guideline of new earthquake countermeasures to promote reparations for a response in the event of such a civil disaster.

Just about the time that the Tokyo Metropolitan Government considered drawing up a disaster prevention plan in case of an inland earthquake underneath Tokyo, the Northridge Earthquake occurred just beneath Los Angeles in 1994 and was followed by the Great Hanshin-Awaji Earthquake beneath Kobe in 1995. Learning from the Great Hanshin-Awaji Earthquake, the Tokyo Metropolitan Government implemented research to estimate the damage that might be caused by four different inland earthquakes occurring underneath Tokyo. The resulting "Report on the Predicted Damage to Tokyo by an Earthquake Directly Beneath the City" was published in 1997.

Table 1 shows a comparison of the damage caused by the 1923 Great Kanto Earthquake, the 1995 Great Hanshin-Awaji Earthquake, the 1991 Predicted Offshore Earthquake and the 1997 Predicted Inland Earthquake. The table shows that the main source of damage inflicted by the 1923 Earthquake were the house fires that left about one hundred thousand persons dead or missing. On the other hand, in the 1995 Great Hanshin-Awaji Earthquake, 5,500 people were killed by the collapse of houses rather than house fires. Fires did occur and about 7,500 houses burnt down in Kobe, but only about 2% of the number that

Table 1 Comparison of Damages amoung Great Earthquakes and Predicted Earthquakes in Tokyo

Earthquake	The Great Earthquakes in Japan of the 20th Century				The Predicted Earthquakes in Tokyo			
	the **Great Kanto** Eq. (1923)		the **Great Hanshin-awaji** (1995)		Massive **Offshore** Type (1991)		Urban **Underneath** Type (1997)	
Magnitude	7.9		7.2		7.9		7.2	
Season	Noon, Satuday, Summer		Early Morning, Monday, Winter		Evening, Week day, Winter		Evening, Week day, Winter	
Losses	<Whole area>	<Tokyo city>	<Whole area>	<Kobe city>	<All Tokyo>	<Ku-wards>	<All Tokyo>	<Ku-wards>
(Persons)								
Dead	99,331	59,065	6,308	4,484	9,363	8,822	7,159	6,717
Missing	43,476	36,294	2	1	----	----	----	----
Injured	103,733	15,674	43,177	14,679	147,068	124,718	158,032	136,825
(Houses)								
Collpsed	128,266	3,886	100,302	61,995	36,343	32,920	42,932	36,971
Damaged	126,233	4,230	108,741	32,114	119,073	104,494	99,596	83,743
Fires	413	136	294	175	758	580	824	627
Burnt	447,128	366,262	7,467	7,388	632,616	477,353	378,401	324,288
Burnt **(ha)**	----	3,830	65	63	22,975	14,075	9,575	7,485

burned after the Great Kanto Earthquake. In 1923, many lost their lives outside the houses on the roads, but in Kobe, about five hundred people, (about 10% of the fatalities) were killed by fire as they lay trapped under collapsed houses.

Even today in Tokyo there are vast areas of densely packed wooden houses. The greatest casualties are expected to occur here. About 366,000 houses burnt down in Tokyo in the aftermath of the 1923 Great Kanto Earthquake over an area of 3,830 hectares in the downtown part of the city. In the scenario of the 1991 Predicted Offshore Earthquake of Magnitude 7.9, it is estimated that about 477,000 houses

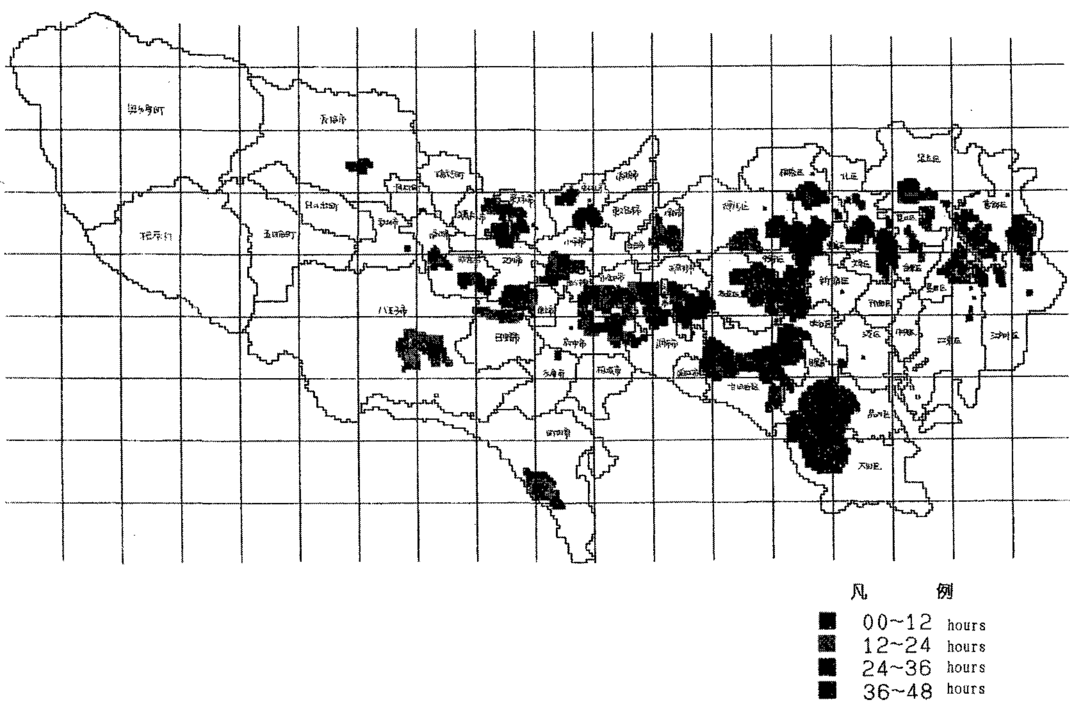


Fig.2 The 1991 Simulation of Fire after the Predicted Earthquake (Offshore Earthquake, M.7.9)

would succumb to fire in Tokyo's 23 wards. It is estimated that a total area of about 14,000 hectares would be razed. Some 8,800 people would die, mainly due to fire (see Fig. 2).

In the scenario of the 1997 Predicted Inland Earthquake of Magnitude 7.2, about 324,000 houses would burn down and 120,000 buildings would collapse totally or partially over 7,500 hectares, mainly in the inner areas where wooden houses are close together. In the scenario, it is estimated that about 2,000 people would be killed by collapsing buildings, and about 5,800 would lose their lives due to fires in the aftermath (see Fig. 3).

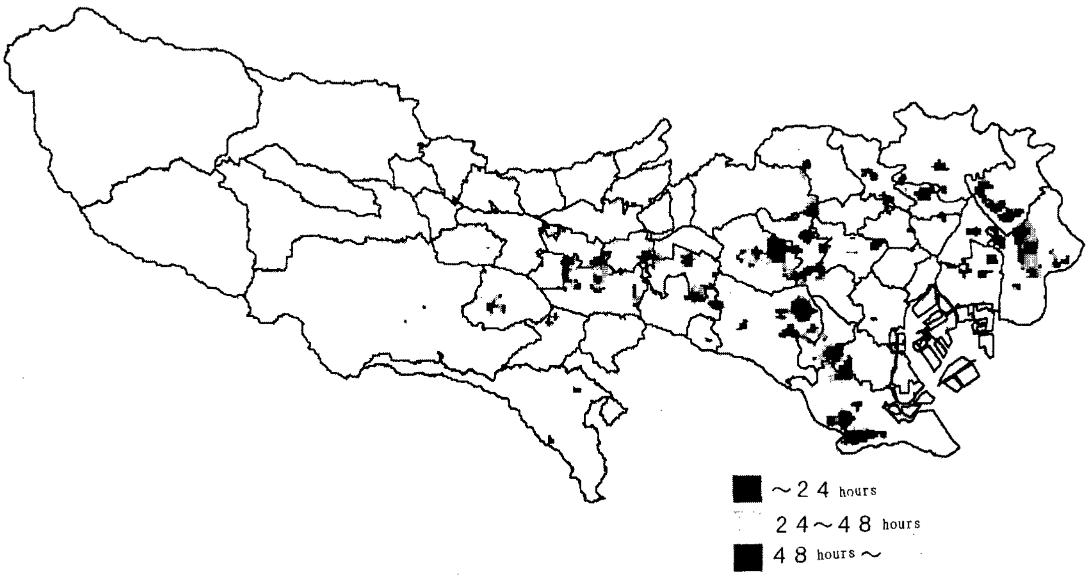


Fig.3 The 1997 Simulation of Fire after the Predicted Earthquake (Inland Earthquake, M.7.2)

If these big fires did not occur after the earthquakes, then the level of damage would be much lower. In Tokyo, these scenarios have indicated that the most important issue in earthquake countermeasures is to improve the state of these areas of crowded wooden housing by transforming them into fireproof and disaster-resistant residential districts.

4. Tokyo's Urban Planning and Promotional Plan for Disaster-resistant City

In spite of the huge number of crowded wooden housing areas, TMG has continued to work to make a disaster-resistant city since the 1970s.

Several years before the 1964 Niigata Earthquake, Professor Hiroshi Kawasumi, a famous seismologist and a member of Tokyo Disaster Prevention Council, reported that large earthquakes have occurred at an interval of 69 years +/- 13 years in the southern Kanto Region. According to his model, the next big one will occur in the period of 1979 to 2005, taking the 1923 Great Kanto Earthquake Disaster as the reference point.

Niigata City is the biggest modern city on the Japan Sea coast. In 1964, Niigata City, which developed in the Shinano river basin, was severely damaged. Many houses collapsed as the land underneath them liquefied. The tremors caused flooding and fires. The eastern part of Tokyo, like Niigata City, is located on flood plains (Ara-kawa river and Naka-gawa river).

Both Kawasumi's model and the destruction of the 1964 Niigata Earthquake made TMG realize the importance of earthquake countermeasure policies, especially for the Koto Delta District which was the most densely inhabited area and characterized by closely packed wooden houses and many small factories.

In 1969, five years after the Niigata Earthquake, TMG produced a development plan for six Disaster Prevention Bases in the Koto Delta District (see Fig. 4). The first plan for the development of a Base in the Shirahige East district was approved in 1972 to be created through urban re-development project. This Base was probably completed in 1985 without the construction of a bridge for refugees. Despite the passage of 27 years since 1972, the six Disaster Prevention Bases have not all been built. Several bases are still under development utilizing various development methods.

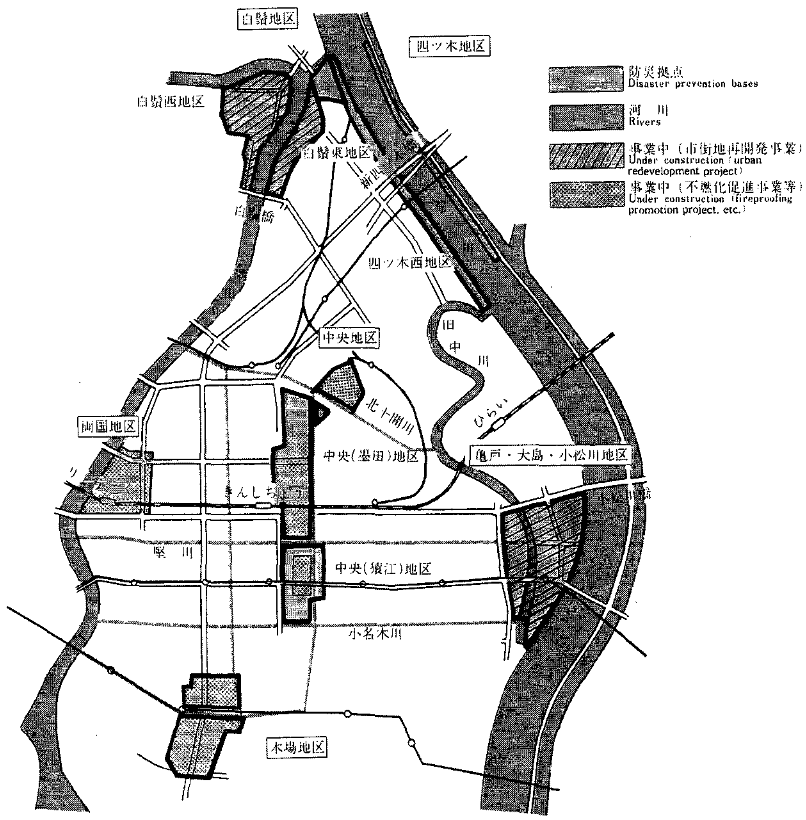


Fig.4 Development Plan of Disaster Prevention Bases in Koto Delta Districts

The first assessment of earthquake area vulnerability of 1975 determined that there were also a large number of very vulnerable areas on the western part of Tokyo around the CBD (see Fig. 5). TMG responded to this finding with a plan in 1981 for the development of disaster-proof living zones (so called Bosai-seikatsu-ken in Japanese) to make residential districts less vulnerable to earthquakes. The concept of a disaster-proof living zone development project involves the following steps: 1) Promotion of firebreaks to make segments of disaster-resistant urban areas. Each living zone is surrounded by firebreaks, which separate out about 700 zones in the 23 -wards of Tokyo. Roads, parks, rivers and railways are improved, and the construction of fireproof buildings is promoted along roads. 2) A disaster-proof living zone surrounded by firebreaks is 80 hectares on average, as large as an elementary or junior high school district. Improvement projects for creating disaster-proof living zones should be carried out with priority in the relatively risk zones. 3) Within this zone, the open spaces are secured and narrow roads are widened. The renewal of old wooden houses and the fireproofing of existing wooden houses are promoted.

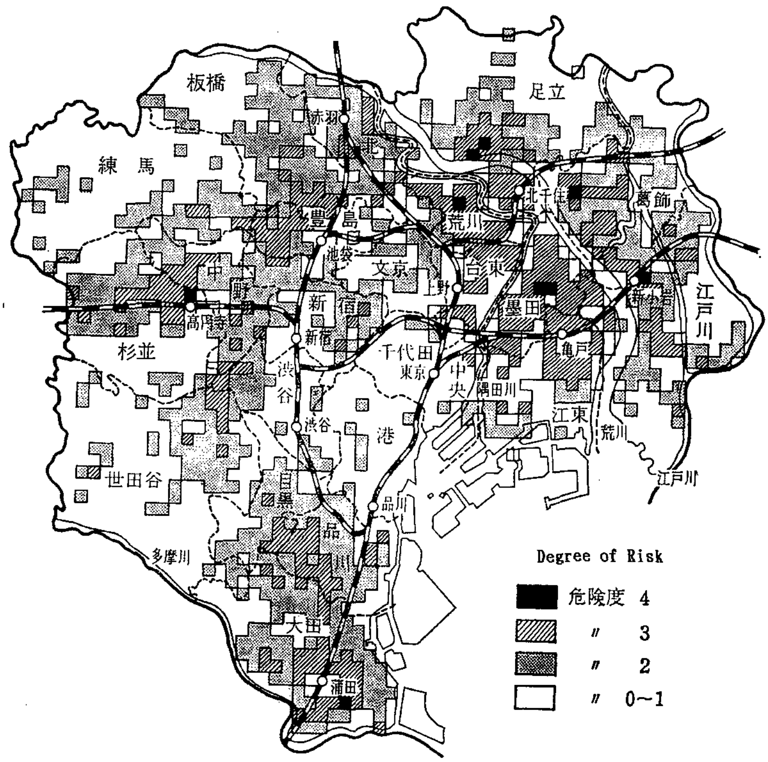


Fig.5 First Assesment of Earthquake Area Vulnerability in 1975

From 1985 to 1992, a model project for disaster-resistant living zone improvement was carried out in three target zones. Since 1993, the promotional project for disaster-resistant living zone improvement has been carried out in sixteen zones.

On 17th January 1995, the Great Hanshin-Awaji Earthquake occurred in the Hanshin metropolitan region. Many structures and wooden houses collapsed. Many wooden houses burnt down in the inner areas of Kobe and many people died. This civil disaster showed Tokyo that the necessity for improving crowded wooden housing areas and strengthening disaster prevention measures is greater than ever before.

Learning from this earthquake, a promotional plan was organized in March 1997 for more effective and concentrated developments of a disaster-resistant city. The planning area for a disaster-proof living zone project extends throughout the 23 wards and the 8 cities in the Tama region because areas with closely packed wooden houses have been spreading toward the Tama region alongside the Chuo Railway line. According to the research reports, the outline of the promotional plan is as follows: 1) The number of disaster-proof living zones will be increased from about 700 zones to 816 zones covering a total of 59,400 hectares; 2) Crowded wooden housing areas comprise 399 zones totaling 28,300 hectares; 3) The number of areas targeted for the promotion of a disaster-proof living zone project are 25, totaling 6,000 hectares; and 4) There are key project districts, which means a promotional model project of disaster-proofing town improvement. In the first step, eleven project areas were set, totaling 1,880 hectares (see Figs. 6 & 7). Since 1998, projects for key project districts and target areas were actively promoted through multi-layered and concentrated works.

Table 2 Construction of Firebreaks in Tokyo (1997)

	Total Length(km)	Construction Rates(%)
Structural Firebreaks	480km	63.1%
Main Firebreaks	286	19.7
The other Firebreaks	798	27.8
Total of firebreaks	1,564	37.8

Disaster-proofing Living Zones:
816 zones, totalling 59,400 ha

Crowded Wooden Housing Areas (Subjected Areas):
399 zones, totalling 28,300 ha
<Indeces>
Area Vulnerability Assessment: Risk Rank 4 & 5
Wooden Houses Rates: more than 70%
Superannuated Wooden Houses Rates: more than 30%
Density (household/hectare): more than 55
fire-proofing Space Rates: less than 60%

Target Areas:
91 zones (25 areas), totalling 6,000 ha
<Indeces>
Area Vulnerability Assessment: Risk Rank 5
Wooden Houses Rates: more than 70%
Superannuated Wooden Houses Rates: more than 45%
Density (household/hectare): more than 80
Fire-proofing Space Rates: less than 40%

Key Project Areas:
11 districts, totalling 1,880 ha

Fig.6 Area Classification in Promotional Plan of Disaster-resistant City in Tokyo (1997)

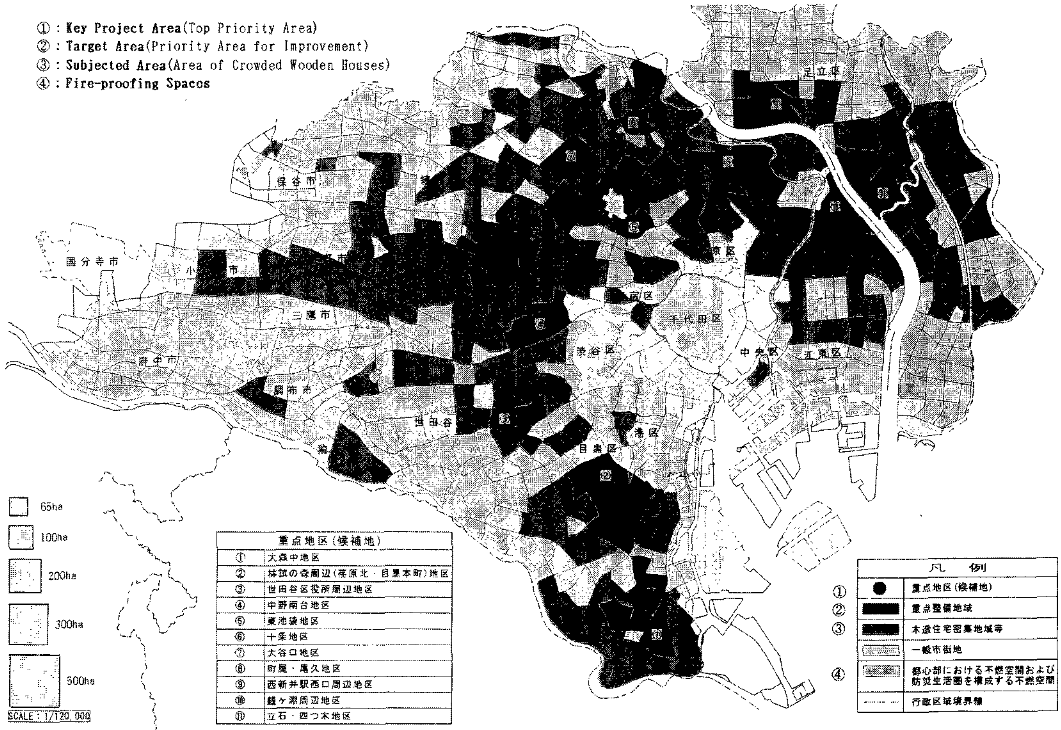


Fig.7 Promotional Plan for Disaster-resistant City (1997)

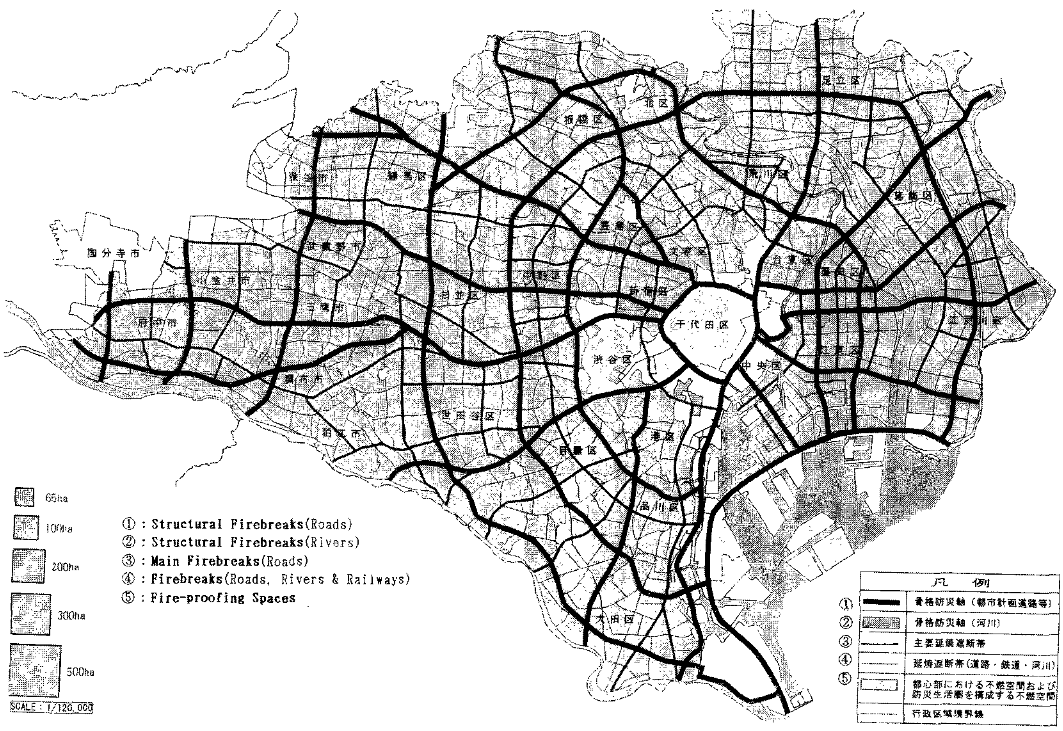


Fig.8 Development Plan of Firebreaks (1997)

The total length of firebreaks increased from 1,240 kilometers to 1,564 kilometers, 60% of which have not yet been completed (see Table 2). The speed of firebreak consolidation is 3 kilometers per year on average over the last 13 years. The planned firebreaks are classified into three priority categories for more efficient development. The first priority of firebreak development is given to main roads as structural firebreaks (480 km). There are 286 km of main firebreaks with a secondary priority. The length of the other firebreaks totals 798 km (see Fig. 8).

5. Concept of the Next Reconstruction Plan and Plan-making Manual

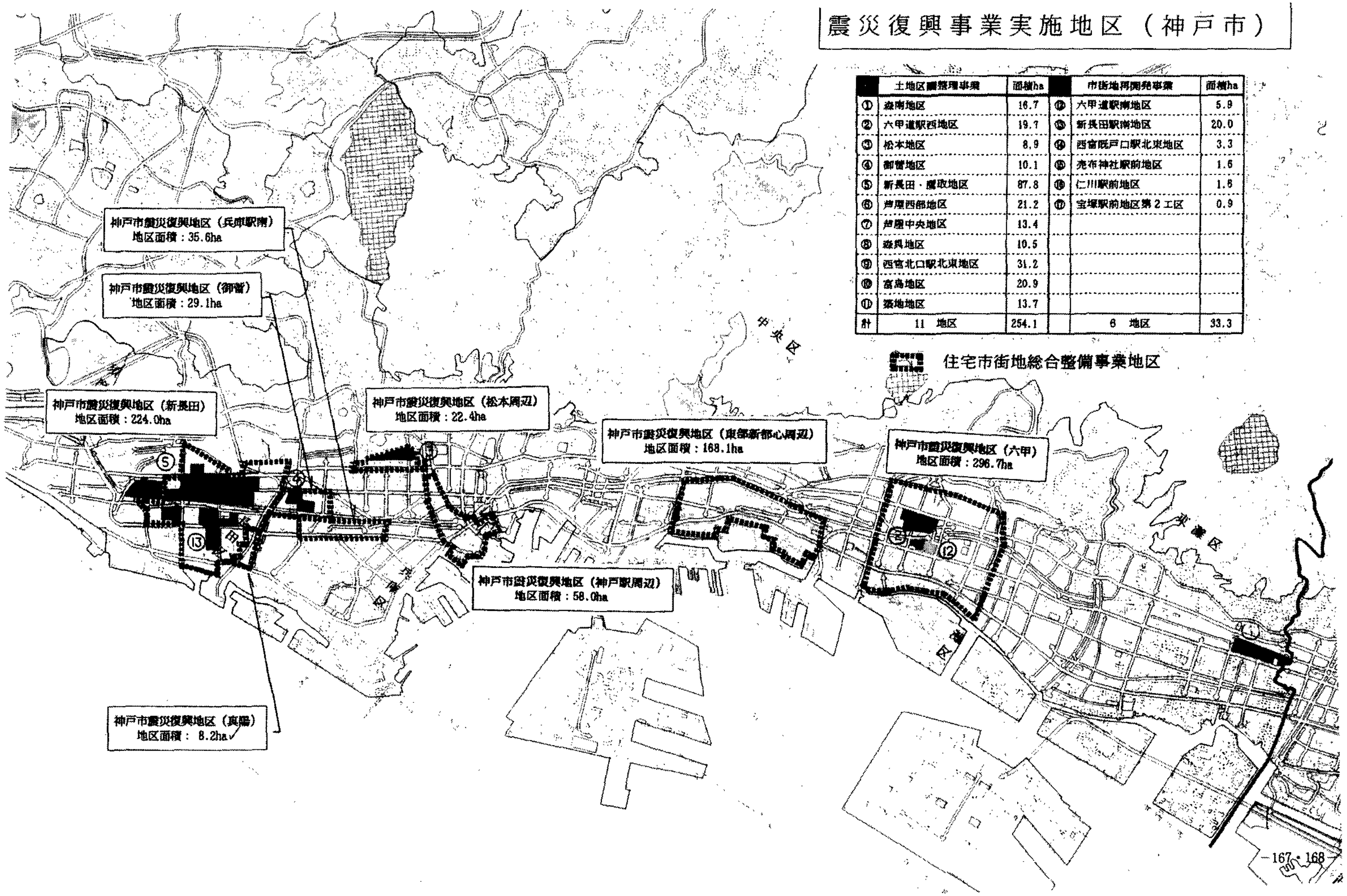
In spite of efforts to promote the creation of a disaster-resistant city, it will be many years before Tokyo can be made resistant to civil disasters. Based on the estimated damage of the 1997 Predicted Earthquake, if extensive fires occur, an area totaling 7,500 hectares shall have to be reconstructed. Such large-scale reconstruction is beyond the ability of individual landowners and would require an extensive urban planning.

The reconstruction planning process of the Great Hanshin-Awaji Earthquake proceeded as follows. The basic research into urban planning for the reconstruction projects started in a few days after the Earthquake. Sketch plans were produced two weeks after the Earthquake, through the zoning of damaged areas for reconstruction projects under urban planning. Legal procedures for the designation of urban planning for reconstruction projects were advanced during a two-month period. On the 17th of March, the urban reconstruction plans for 16 districts, totaling 274 hectares, were designated according to the procedures of the Urban Planning Act (see Fig. 9). However, many people objected to the designations and the details of the reconstruction project to be carried out through "land readjustments and urban redevelopments." Since the Earthquake, there have been many debates on the modern method of recovery and reconstruction, the process of designation of urban planning for reconstruction, public involvement in legal procedure of planning and reconstruction work, and so on. Today, reconstruction work is advancing in many of the reconstruction project districts through the process of land readjustment and urban redevelopment.

No districts have yet been completed in the four years after the Earthquake. Ten years will probably be needed to complete all the reconstruction. It is significant to note that reconstruction works are going ahead more effectively in the districts where the residents had coped well with the community development projects (such as town improvement projects) before the Earthquake by themselves and had cooperated with local governments.

Tokyo has learned important lessons from the experiences of Kobe City and Hyogo Prefecture. Not only has it pursued the promotion of "earthquake-proofing," such as the fireproofing of buildings, urban infrastructure renovation, and retrofitting of old buildings, but it has also developed the skills to assure that the reconstruction projects run smoothly and effectively. This is especially important because Tokyo contains some 28,000 hectares of crowded wooden housing areas, including 6,000 hectares of greater-risk districts with old wooden houses and narrow alleyways. Since it is not a question of "if," but "when" the Big One will hit, the Tokyo Metropolitan Government has proposed to make the city safer within twenty years, based on the Promotional Plan for a Disaster-resistant City.

Tokyo has learned many lessons on the urban reconstruction measures. It has learned how to



	土地区画整理事業	面積ha		市街地再開発事業	面積ha
①	森南地区	16.7	⑫	六甲道駅南地区	5.9
②	六甲道駅西地区	19.7	⑬	新長田駅南地区	20.0
③	松本地区	8.9	⑭	西宮東口駅北東地区	3.3
④	御菅地区	10.1	⑮	売布神社駅前地区	1.6
⑤	新長田・鷹取地区	87.8	⑯	仁川駅前地区	1.6
⑥	芦屋西部地区	21.2	⑰	宝塚駅前地区第2工区	0.9
⑦	芦屋中央地区	13.4			
⑧	森具地区	10.5			
⑨	西宮北口駅北東地区	31.2			
⑩	富島地区	20.9			
⑪	築地地区	13.7			
計	11 地区	254.1		6 地区	33.3

Fig.9 Reconstruction Projects in Kobe (1995)

designate a reconstruction plan rapidly through public involvement, how to implement reconstruction works smoothly, how to improve and reconstruct the environment, and how to decide what districts are to be given high priority in urban reconstruction. In 1995, Tokyo started research into the basic concept of urban reconstruction, technical methodology of the planning process and legal procedure within public involvement, and preparedness for reconstruction plan making. It has issued comprehensive guidelines for smooth reconstruction and successful recovery.

In 1997, Tokyo Metropolitan Government published the Tokyo Metropolitan Urban Reconstruction Manual (TURM). TURM is a manual for urban reconstruction planning in Tokyo, and sets forth planning guidelines for prefectural and regional officers, and guidelines for urban recovery pre-publicity for the general public. In 1998, TMG publicized another report, entitled Tokyo Metropolitan Life Recovery Manual (TLRM), a manual for the listing of the order of activities to be undertaken during the recovery period, such as the supply of temporary housing and home reconstruction, services for livelihood recovery and support for economic activities of individuals and companies. In other words: checklists for the actions of prefectural and regional officers. Both manuals function like the wheels of the vehicle of urban recovery and reconstruction actions of the Tokyo Metropolitan Government.

How shall Tokyo be rebuilt after the next big earthquake? According to the TURM guidelines, the urban reconstruction plan will be produced on three layers. Layer 1 will be the Promotional Plan for Disaster-resistant City (1997) and the layout of streets. Layer 2 will be both current urban plans such as the Housing Master Plan (1995) and the Urban Redevelopment Master Plan (1996), and the arrangement of planned infrastructure, especially roads and parks. Layer 3 will be the distribution and concentration of damage caused by the next big earthquake (see Fig. 10). Layers 1 and 2 may be prepared before the next big earthquake, but Layer 3 cannot be prepared until after the Big One actually strikes.

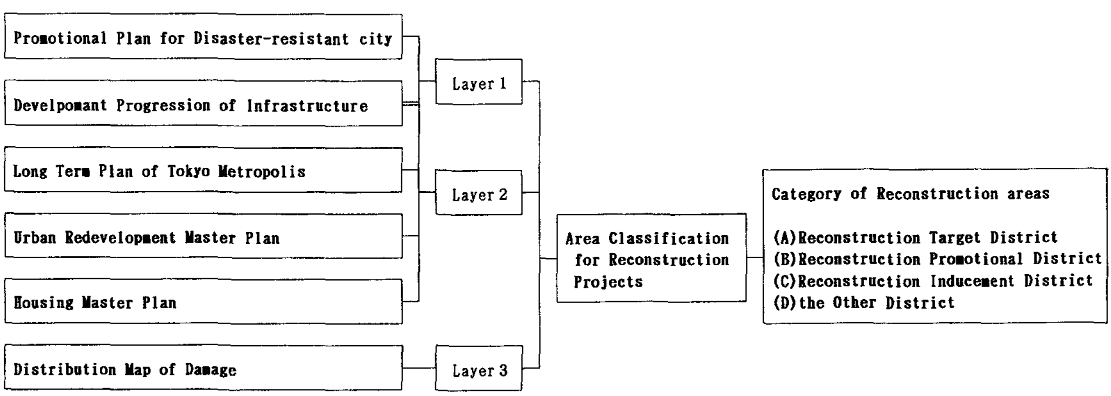


Fig.10 Conceptual Flow of Area Classification for Urban Reconstruction Planning (1997)

Layer 1: Built-up areas are classified into four categories based on the relationship between the Promotional Plan of a Disaster-resistant City (PPDC) and the Arrangement Situation of Urban Infrastructures (ASUI). The PPDC is further divided into the Target area, general Crowded Wooden Housing area, the Other area and the existed Fireproofing Districts of the CBD. ASUI classifies built-up areas as Arranged areas and Non-arranged areas. Category (A) includes areas that not only belong to the

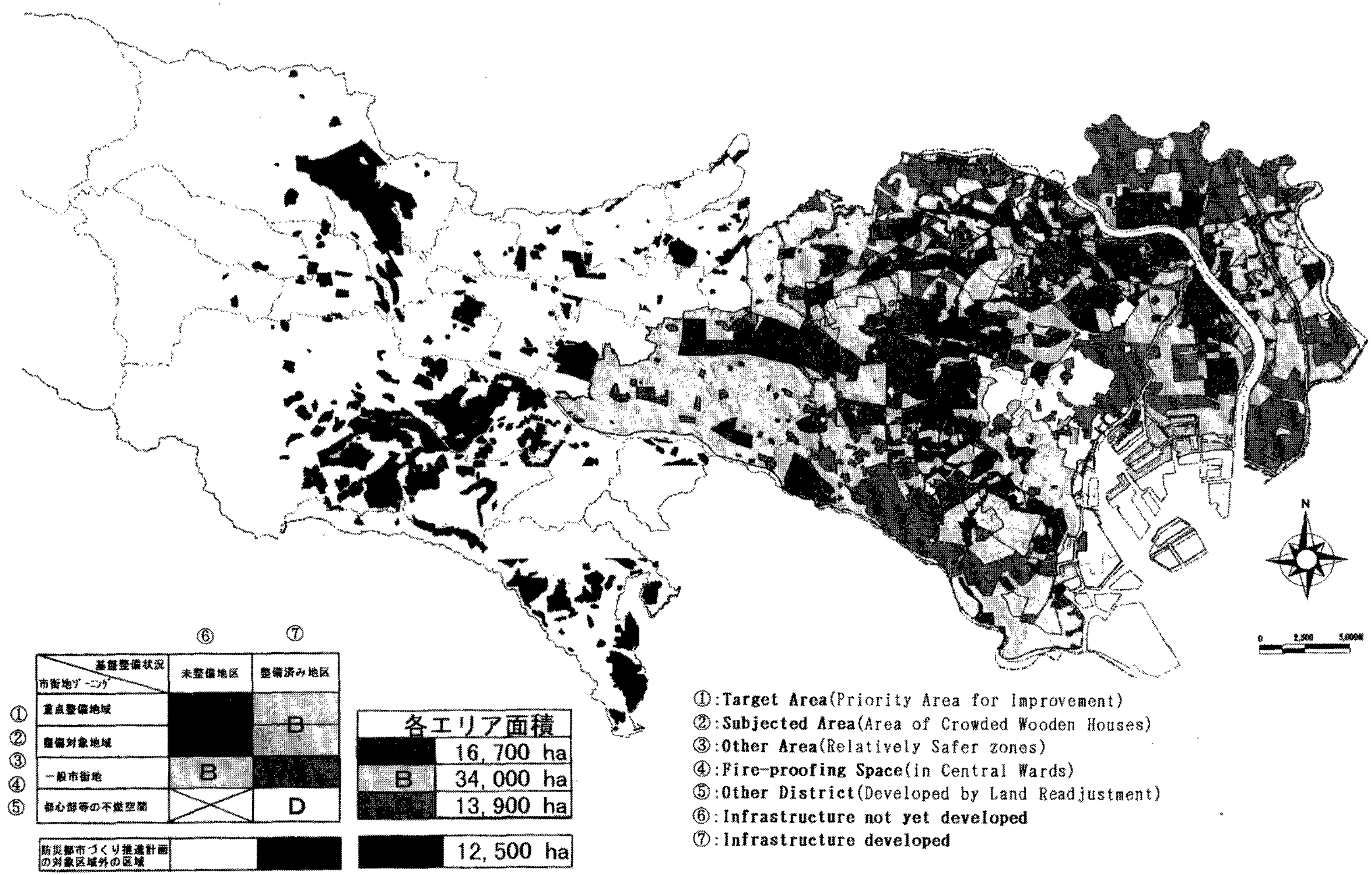
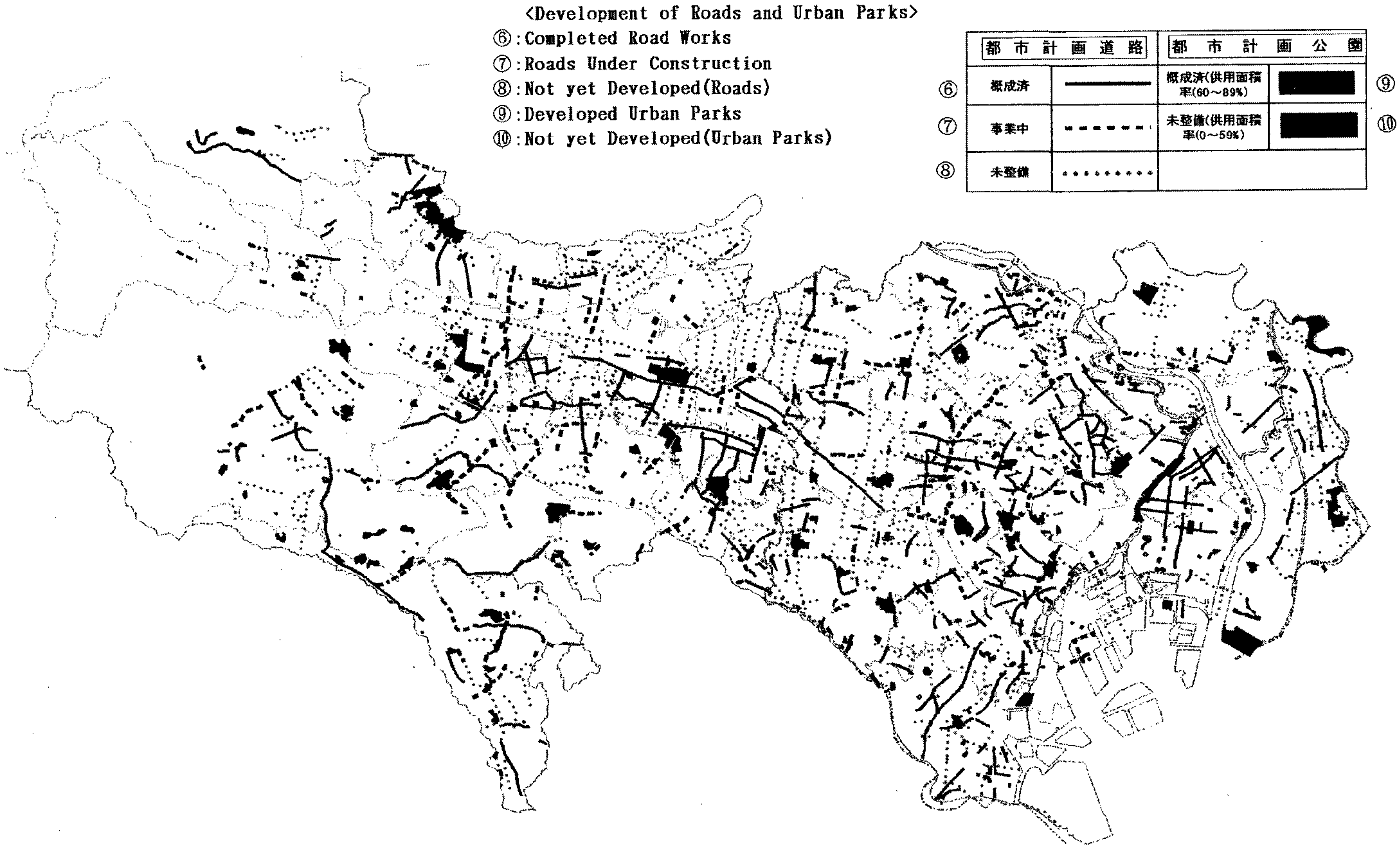


Fig.11 Layer 1: Area Classification according to Promotional Plan and Infrastructural Condition



Roads designated as urban Planning(in 1997)

Planned Length	Developed	under Construction	Not yet
3，126km	1，532km	354km	1，240km

Parks designated as urban Planning(in 1995)

Planned Area	Developed	Opened	Not yet Developed
4，840ha	1，337ha	1，203ha	3，503ha

Fig.12　Main Infrastructure to be Developed

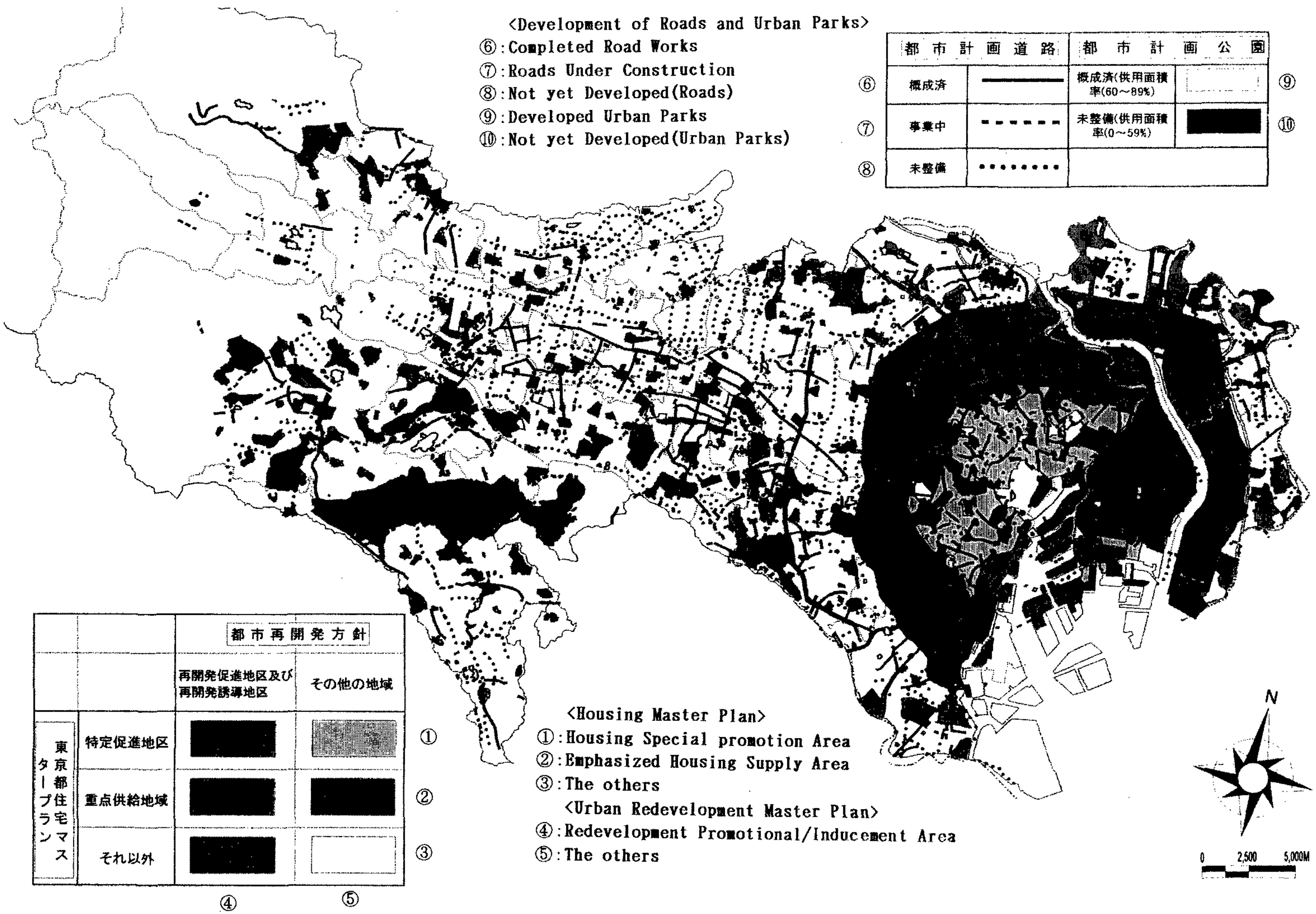


Fig.13 Layer 2 : Area Classification according to Master Plans and Infrastructural Development

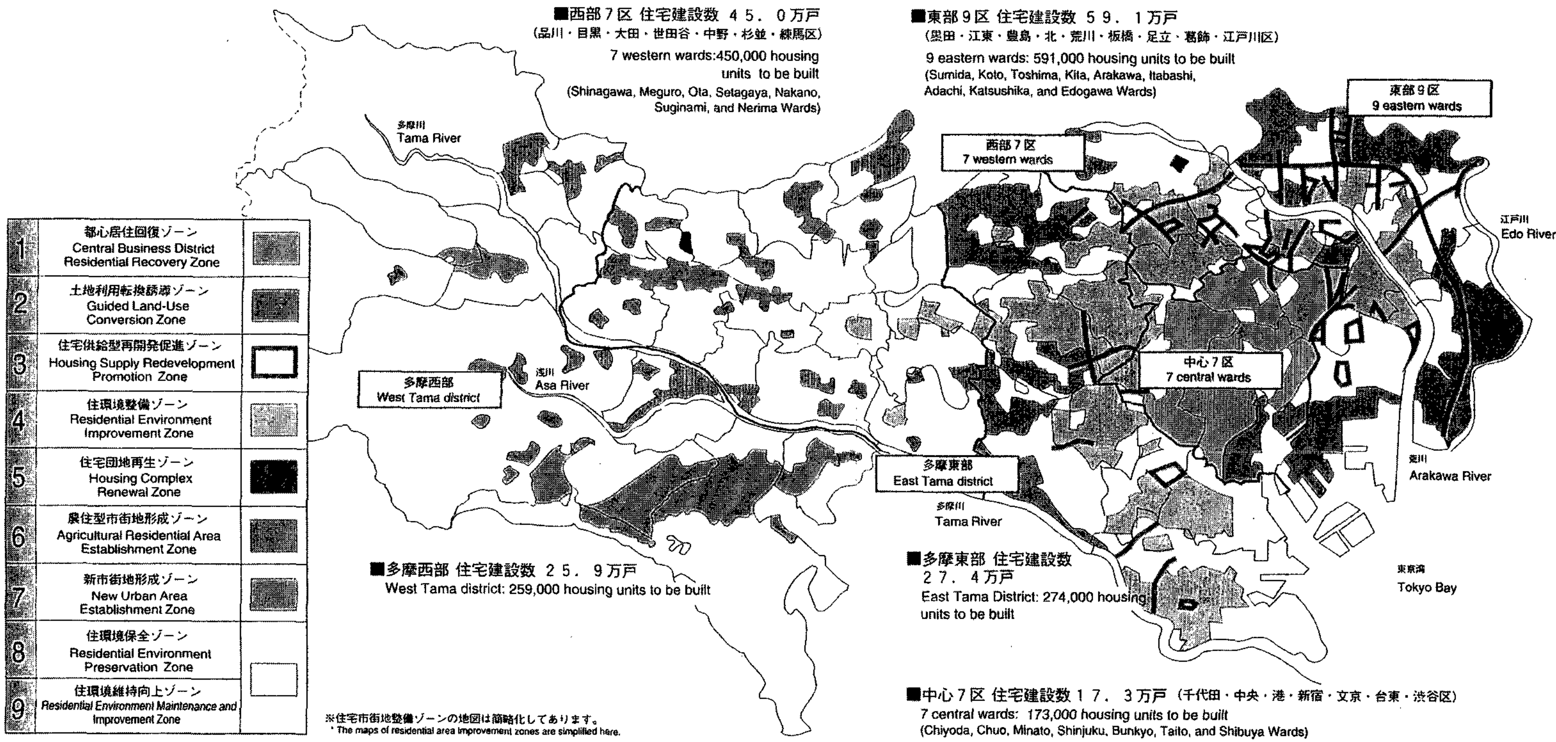


Fig.14 Housing Master Plan (1995): Improvements in Urban Residential Areas due to Housing Characteristics of Area

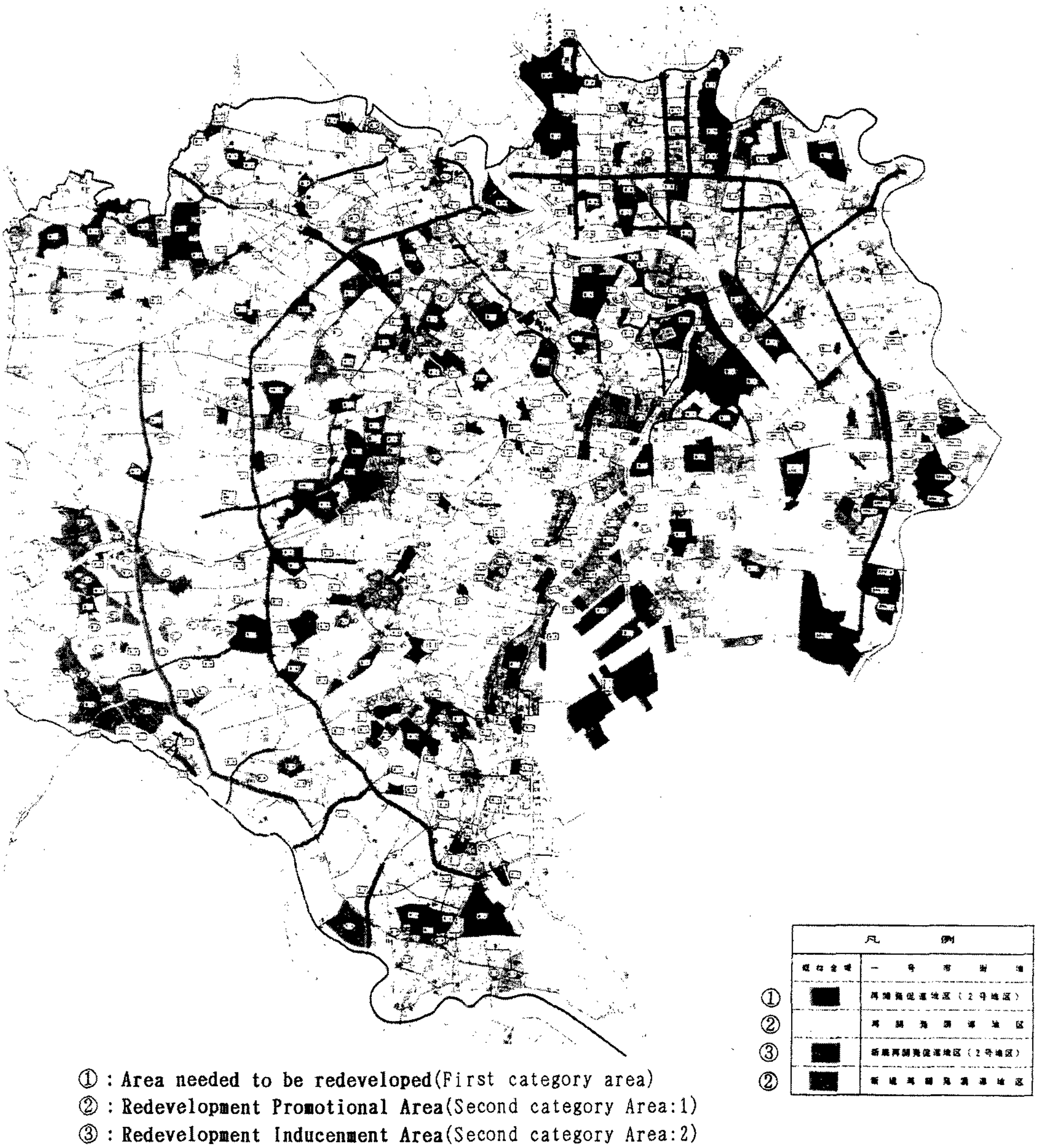


Fig.15 Urban Redevelopment Master Plan (in May 1996)

Target area (for a disaster-resistant city) and the Crowded Wooden Housing area, but also to the Non-arranged areas of infrastructure. In Category (A) there are districts that must be reconstructed through public works such as a land readjustment and/or urban redevelopment of urban planning projects. In Category (B) there are districts where planned reconstruction will be promoted. In Category (C) there are districts where individual reconstruction will be induced. In Category (D) there are other districts. In this way Layer 1 clarifies the districts where urban reconstruction must be implemented (see Figs. 7, 11 & 12).

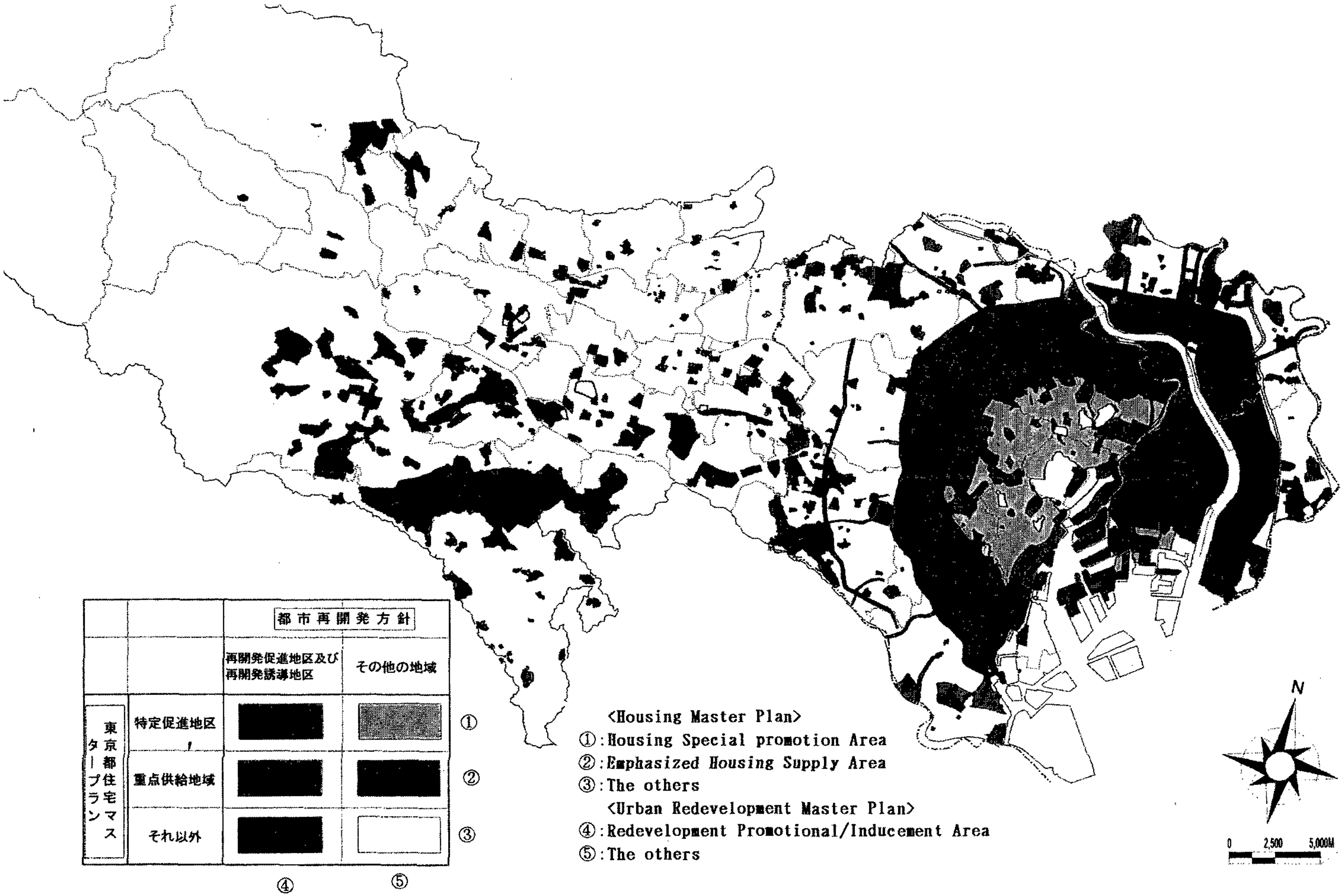


Fig.16 Area Classification according to Urban Redevelopment Master Plan and Housing Master Plan

Layer 2: Built-up areas are classified from the viewpoint of urban policies and various master plans, such as the Long Term Plan for Tokyo Metropolis (LTPTM), Tokyo Urban Redevelopment Master Plan (TURMP), Tokyo Housing Master Plan (THMP) and Infrastructure Development Program of Tokyo (IDPT). In most cases, built-up areas are classified into six categories based on the relationship between TURMP and THMP. Under TURMP, the built-up areas of the 23 wards of Tokyo are divided into Redevelopment Promotion Areas, Redevelopment Inducement Areas and Other Urban Areas. Under THMP, the areas of Tokyo are divided into nine zones. Of these, two kinds of districts for housing development or housing improvement are designated: Housing Special Promotion Areas and Emphasized Housing Supply Areas. Layer 2 consists of both area classification and arrangement condition of urban infrastructures, such as roads and parks. Layer 2 indicates the conceptual direction of the contents of urban reconstruction planning (see Figs. 13, 14 & 15)

Layer 3 is the map showing the distribution of damage, to indicate where damage is concentrated. Although Layer 1 and Layer 2 can be prepared before the next big earthquake, Layer 3 cannot be prepared until after the Big One strikes. Layer 3 must be made as soon as possible after the big earthquake; however, damage research programs can be prepared in advance.

If the Big One turns out to be similar to predictions, Layer 3 will be similar to the damage estimations (see Figs. 2 & 3). Land re-adjustment for urban reconstruction will have to be carried out in burnt-out districts. Urban redevelopment will go ahead in districts that have the potential to support urban activities such as commerce and culture.

6. Conclusions

Japan's first modern urban planning act was established in 1919. However, the reconstruction plans and works that came after the 1923 Great Kanto Earthquake and the bombing of 1945 were implemented under special acts for reconstruction, not under the normal Urban Planning Act. Reconstruction plans and works in the aftermath of the Great Hansin-Awaji Earthquake are being implemented under the normal Urban Planning Act re-established in 1968 and revised in 1992, instead of the Special Act for Urban Reconstruction established after this earthquake in February of 1995.

Nobody knows when the next big earthquake will hit Tokyo, but it is likely that Tokyo will be reconstructed through two acts: the Urban Planning Act and the new Special Act for Urban Reconstruction. This will be the first experience for Tokyo.

It is vital not only to train in reconstruction plan making, but also to publicize the basic concepts of Tokyo's reconstruction to increase people's awareness of the contents of each district plan. Furthermore, under the Promotional Plan for Disaster-resistant City, it is important for officials and residents to discuss the ideal environment of each district (community) to set the direction of each reconstruction project for each district in the pre-event period.

TMG is learning more lessons by itself. On the 4th of September in 1998, the Tokyo Metropolitan Government implemented the first exercise for reconstruction plan making, involving lower-tier governments of seven wards. This exercise is implemented every year, which is conducted by TMG with more than ten local authorities. Through these exercises, TMG Urban Reconstruction Planning Manual will be revised in 2002 or near future.

On the other hand, after the second exercise of 1999, the mayor of TMG commented that the Tokyo's Ground Design for Urban Reconstruction Plan(TGDUR) is necessary not to rehabilitate nor to repair the damaged areas of Tokyo but to reconstruct creatively a new Tokyo. This comment promoted to make the Tokyo's Ground Design for Urban Reconstruction Plan; what urban structural design shall be imaged as a creative reconstruction for a new Tokyo? In the same time, several new technological methods are clarified to implement a new urban reconstruction projects according to the TGDUR, such as new type of land readjustment project. In 2001, TMG published the TGDUR and begun to discuss these new technological methods with the Ministry of National Land and Transportation. TMG also begins to revise the Tokyo's Urban Reconstruction Planning Manual, learned from the exercises.

The Urban Reconstruction Planning Manuals also must be established by every local authority. Today, several local authorities(ward authorities) established their own Town Reconstruction Planning Manuals and have done the unique exercises of a town reconstruction planning in the participation of local residents.

Anyway, the exercise for urban reconstruction planning shall be repeated as often as possible in the remaining time until the Big One arrives by TMG and Local Authorities. However, the most important countermeasure against the Big One is not the enlargement and development of preparedness measures for recovery and reconstruction of damages after the earthquake, but the implementation of disaster-proofing measures for making disaster-resistant city, because only this measure is able to reduce damages of Tokyo from earthquake disaster. Therefore, TMG and Local Authorities have to promote the disaster-proofing urban planning projects through the discussion with local residents. If the residents do not want to do urban reconstruction and house rebuilding in a very severe condition after earthquake, they have to prefer and to implement the disaster-proofing urban projects before the Big One arrives.

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Key Words（キー・ワード）

Earthquake（地震）, Urban Reconstruction Plan（都市復興計画）, Promortion Plan for Disaster-resistant City（防災都市づくり推進計画）, Area Vulnerability Assessment（地域危険度評価）, Preparedness Plan for Urban Reconstruction（復興準備計画）/（事前復興計画）, Tokyo（東京）

次の直下地震から東京はどのように復興されるべきか
－阪神大震災と東京の事前復興都市計画の取り組み－

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本論文は、南関東で発生が危惧されている直下の地震に対して、東京都では地震被害想定を前提に、被災地域の都市復興をどのように進めるべきかを事前検討することとした。その検討メンバーの一人である著者は、阪神大震災での都市復興過程を基礎に、それを上回る被害の発生が想定される東京区部直下の地震に対する「事前復興計画」の考え方を整理した。本論文は、「東京都都市復興マニュアル」を紹介しつつ、都市復興及びその事前準備の課題を考察したものである。本論文の構成は以下である。

1．東京の都市構造と地震に対する地域危険度評価
2．東京の地震環境と危惧される南関東の直下地震
3．東京における区部直下地震の被害想定
4．東京の都市計画の系譜と防災都市づくり推進計画
5．来るべき東京の都市復興概念と復興計画策定マニュアルの考え方
6．考察

最も重要な課題は、如何に市民（被災者）の参加と理解を得ながら、都市復興計画に合意し、事業の実施を推進することが出来るかという課題である。そのためには、災害後に復興街づくりが始まるのではなく、被災が危惧される木造密集市街地で、事前に、どのように街づくりを市民と協働で取り組んでおくか、が重要であることを述べた。