Analyzing the state of high-density areas in Japan after redevelopment projects

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Abstract. Japan has many high-density residential areas that are prone to disasters. Therefore, the Ministry of Land, Infrastructure, Transport, and Tourism has conducted various projects to improve these areas. Housing environment issues have also become a major issue. Consequently, this study considers the activities in the redevelopment project and the issues that emerge afterward in the Setagaya ward (Tokyo), where the high-density area redevelopment was conducted. A result is the increase of young people and households in the area although the number of old people is still increasing. However, in the Setagaya area, a comparison of the population density and the green area ratio in 2011 and 2016 shows that the green area ratio increased although the population density in 2016 was higher than in 2011. This occurred due to the redevelopment of the ruins of the National Children’s Hospital into a condominium in 2008 and the efforts to achieve a green rate area ratio of 33% in Setagaya Ward by 2032. Green space has various functions in cities including in disaster prevention. As Japan is prone to disasters, the provision of green space is crucial.

1. Introduction

1.1. Background and purpose
High-density areas are widely distributed in the periphery of large cities such as Tokyo and Osaka. They were formed as a result of historical town splits in the Meiji and Taisho periods or without the land readjustment from before the war. These areas were spontaneously formed due to rapid population growth in large cities during the period of economic boom occurring since 1955. In contrast, in local cities, high-density areas are often found in the city center. These typically developed as a downtown area of historic castle town or a post town located on a highway. High-density areas lack public facilities such as roads and parks due to narrow roads, many dead-end streets, densely packed old wooden buildings, and narrow plots. These areas generally have urban characteristics such as many buildings that do not meet building standards. Another feature is the complex relationship of rights related to land and buildings, such as a large number of leased land and houses [1].

High-density areas are redeveloped through projects such as land readjustment and urban redevelopment projects. These projects generally take a long time due to the process of forming agreements with landowners and changes in city planning. However, a survey by the Ministry of Land, Infrastructure, Transport and Tourism found that the development of high-density areas has progressed steadily, improving safety and disaster prevention [1]. However, in recent years, high-density areas have faced problems in the living environment such as aging residents and the increase in vacant
houses. These issues were the topic of a symposium titled “Disaster Prevention and Environment Improvement for High-Density Areas 2017” by the Independent Administrative Corporation Urban Organization in 2017. Future improvements in high-density areas were discussed, emphasizing the need to improve the living environment through enhancing the disaster prevention function and town development that aims to balance safety and comfort of living [2].

This research aims to develop strategies for good urban development in the future, targeting the Taishido 2 and 3 chome districts in the Setagaya Ward which have been redeveloped. This study assessed the situation in these high-density districts after the redevelopment. Specifically, the purpose of the study was to organize the efforts of the high-density redevelopment project in the Setagaya Ward Taishido area and to discuss relevant issues.

1.2. Selection of study area
Setagaya-ku Taishido 2-3 chome district were selected as the study area because the urban redevelopment for disaster prevention involving resident participation began since 1980. The redevelopment is a reparation type instead of a clearance method of scrap & build. This area is the most densely urbanized area in the whole country and redevelopment efforts were made early on. Therefore, it was thought that it would reduce problems after redevelopment. In addition, 70 percent of properties in the Setagaya Ward, which includes the Taishido area, are buildings used for housing and the area is characterized by an annual increase in population density.

1.3. The positioning of this research
Past studies on elderly people and high-density areas targeted Higashikubo-cho, Nishi-ku, Yokohama City, where Iida et al. studied the conditions of these high-density urban areas that developed awareness for the elderly [3]. This research clarified the features of improvements in densely populated urban areas. Other studies have focused on the problems during redevelopment projects in high-density areas, such as the efforts and problems related to block redevelopment projects for disaster prevention [4]. Furthermore, Kim et al. conducted research on the high-density urban area redevelopment system, focusing on a linked building design system and explaining the characteristics and problems encountered during the operation in each area [5]. This paper is unique in considering the factual conditions in the area after its redevelopment while using the same viewpoints as the aforementioned studies.

2. Ministry of Land, Infrastructure, Transport and Tourism and the Tokyo Metropolitan Government
2.1. The positioning of this research
One of the goals of the Basic Plan on Housing and Living (National Plan), which was enacted by the government on March 15, 2011, is to substantially eliminate earthquake risks in vulnerable high-density areas. The Ministry of Land, Infrastructure, Transport and Tourism conducted surveys of municipalities across the country to develop a detailed overview of these areas. To ensure minimum safety standards are applied, the areas were assessed based on the assumptions that fire does not spread continuously, and evacuation is difficult especially in the case of multiple simultaneous fires at the time of an earthquake. The index of "danger of spreading fire" is a standard to judge the danger of large urban fires at the time of earthquakes. Moreover, "difficulty to find refuge" is a standard to judge the difficulty of evacuation at the time of an earthquake. Based on the characteristics of each area, the state of each local government was determined by assessing the "vulnerable high-density urban area at the time of an earthquake"[1]. According to the inspection results of the Ministry of Land, Infrastructure, Transport and Tourism in the fiscal year of 2016, efforts to reduce the risk of fire spreading will be targeted at 1706 ha of the prefecture. As for the remaining vulnerable condition found in 4039 ha, for which the minimum safety standards have been unmet, it will be resolved by the fiscal year 2020.
Redevelopment measures include spreading roadblocks, building large-scale parks and fire-retardant buildings. Meanwhile, city-level measures are carried out through joint rebuilding of high-density areas and removing vacant houses. Detailed measures at the district level are needed for situations that are difficult to assess such as the effects of improvements such as fire prevention and repairs, the elimination of dead-end streets, and the aim to implement redevelopment efforts [1]. Furthermore, since 2011, based on lessons from the Great East Japan Earthquake, discussions on “national resilience” took place. Since then green infrastructure was used more prominently as a way to mitigate and prevent disasters utilizing various natural functions possessed by the environment besides concrete structures. Green infrastructure is positioned as one of the important measures for Japan in the National Land Development Plan, which was enacted by the Cabinet in August 2015, and the Social Capital Development Plan, which was enacted by the Cabinet in September of the same year. As a concrete example of green infrastructure efforts, the National Land Development Plan advocates the redevelopment of parks and green areas with functions such as the creation of multiple rivers and green seawalls to prevent the spread of fires [6].

| Prefectures | The end of 2010 | The end of 2016 |
|-------------|----------------|----------------|
| Saitama     | 54             | 54             |
| Chiba       | 9              | 8              |
| Tokyo       | 1683           | 824            |
| Kanagawa    | 690            | 57             |
| Aichi       | 104            | 104            |
| Shiga       | 10             | 10             |
| Kyoto       | 362            | 362            |
| Osaka       | 2248           | 2248           |
| Hyogo       | 225            | 199            |
| Wakayama    | 13             | 1              |
| Tokushima   | 30             | 26             |
| Kagawa      | 3              | 3              |
| Ehime       | 4              | 0              |
| Kochi       | 22             | 22             |
| Nagasaki    | 262            | 120            |
| Oita        | 26             | 0              |
| Okinawa     | 2              | 2              |
| **Total**   | **5745**       | **4039**       |

2.2. Redevelopment efforts in Tokyo
Tokyo has many districts and high-density areas that are widely spread out around the JR Yamanote Line. Although these areas were formed through rapid post-war urbanization, to this day, urban infrastructure such as roads and parks is insufficient. In addition, the accumulation of aging wooden buildings emphasizes the need for disaster prevention. Thus, Tokyo has a problem with its living
environment. Given the urgency of the Tokyo Metropolitan Earthquake and the occurrence of the Great East Japan Earthquake, it is clear that improvements of the high-density areas - Tokyo's greatest weakness - must be further accelerated to protect the city and its urban functions.

In the city planning for disaster prevention in Tokyo, the concept of “disaster prevention living area” is adopted in the “urban disaster prevention facility basic plan” of 1981. This regulates the perimeter of urban areas of a certain size with fire blocking zones that prevent the spread of urban fires. Various measures have been implemented such as disaster prevention areas, urban disaster prevention, and fireproofing. However, disaster prevention was not the priority of the plan. Consequently, projects were not implemented systematically and disaster prevention was ineffective. In addition, disaster prevention roads that are wider than 6 meters have a positive effect on the district plan, promote redevelopment and promote road redevelopment, e.g., the fire-retardant rebuilding of roadsides along with road redevelopment. This leads to the acceleration of fireproofing and earthquake resistance. Furthermore, for urban areas other than the redevelopment areas, the division of sites by the district plan prevents the increase and expansion of high-density areas. The redevelopment area was the area where the greatest damage is expected, comprised 28 area of 6,900 ha high density area. In cooperation with the city, specifically, a new fire protection area should enhance the city's fire resistance. Based on the above, Japan promotes the redevelopment of roads to become barriers that stop the spread of fires, as well as the fire-retardant and earthquake-resistant qualities of buildings.

The rate of road redevelopment in the redevelopment area was about 50% (Fiscal Year 2010). In addition, the ratio of fire-retardant areas was 49% in 1996, which increased to 56% in 2006. Further efforts will be made to achieve the targets (70% in 2025) of the disaster prevention urban development plan. With this background in mind, the Tokyo Metropolitan Government is working on the "Densely Fireproofed Ten-Year Project" to further accelerate the improvement of wooden congested areas. Focused and intensive efforts are carried out in the years leading up to the fiscal year 2020 to achieve the goal of the initiative, especially for redevelopment areas where significant damage is expected. These efforts will specifically promote the formation of fire-retardant areas to achieve zero spread of fire in high-density areas. This is done to achieve a fire-retardant area rate of 70%. Furthermore, “specific redevelopment routes” are implemented to prevent the spread of fire across roads with a target of 100% redevelopment (28 sections of 26 km) (Figure 2) [7].

![Figure 1. Fire spreading zones [7]](image_url)
3. Redevelopment efforts in Taishido 2-3

According to the “Study on the degree of danger according to the six-level evaluation of the city by Setagaya Ward” in 1979, Taishido 2 and 3rd districts were judged as being some of the highest risk areas in Setagaya Ward. Tokyo promotes the creation of a disaster-prevention town in Taishido 2-3 chome district together with the residents. Here, urban development is based on the town development regulations for Setagaya Ward in the "town development plan" formulated in 1985. This plan was revised in 1995 and was revised again in 2008 [8].

The Setagaya-ku Taishido 3-chome area and the area of the ruins of the former National Children's Hospital, Setagaya-ku were designated as a disaster prevention town development model in 1980 because of the high risk of earthquakes in the Taishido area. The plan was a redevelopment project. In 1982, the Ministry of Construction carried out a comprehensive redevelopment project for the construction of wooden rental housing. Furthermore, in 1986, the Ministry of Land, Infrastructure, Transport and Tourism carried out a green area network project for disaster prevention that comprised fireproofing, redevelopment of narrow roads, the creation of open spaces and parks, and increasing the fireproofing rate to 50%. In March 2003, the Urban Infrastructure Development Public Corp. acquired the site of the National Children's Hospital at Taishido 3-chome. Subsequently, Setagaya Ward designed the "National Children's Hospital ruins area town development policy and plan" in response to the request of the residents in March 2004. Therefore, the government cleared the entire area including the ruins of the Ministry of Justice training office next to Mishuku 2-chome. It was designated as a guidance area and the government decided to redevelop it into a large evacuation shelter area [2].

The Setagaya Ward heavy rain measures action plan was issued in June 2018. This plan seeks to increase rainwater infiltration facilities of road, park, public facilities to control rainwater runoff. In addition, the establishment of rainwater infiltration facilities at private houses (including subsidies for rainwater tank installation) was promoted, through the recovery of the natural water circulation using rainstorm measures by green infrastructure [9].

Figure 2. Specific redevelopment routes [7]
Figure 3. Taishido 3-chome district redevelopment [2]

4. Analysis
This section discusses various materials to clarify the issues after redevelopment in the Taishido district in Setagaya-ku. After the introduction of the project, the number of households increased slightly. This is also true for the proportion of the population over the age of 65. In response to the recent urban phenomena, mini development has increased as one house has been rebuilt into several buildings. This eliminated the space between dwellings, causing a noticeable decrease in green space. Greenery and farmland on privately-owned lands – precious green resources - tend to decrease. The green area ratio of Setagaya, including Taishido, is low especially in the Kitazawa area among the five areas in the ward. There are fewer changes in the area compared to other areas, other than the relatively large residential area and it seems that there are few new development projects. Therefore, it can be concluded that the green coverage change was small, and the growth of the area was low [10].

The number of elderly people and the rate of aging increases yearly in Taikodo 2 and 3 chome districts in recent years (see Figure 6). The rate aging population of 18.84% was the highest in 18 years, whereas, it was the lowest in 2011 and 2016. The redevelopment of the former National Children's Hospital ruins into three condominiums and rental apartments in 2008 has increased the disaster prevention conditions e.g., through the redevelopment of the site leading to the use of open space as a shelter during disasters. It is thought that the number of young people also increased due to the construction of high-quality housing and the convenience of transportation to the downtown area, which is a feature of high-density areas.
In addition, looking at the population density and the green area ratio in Setagaya Ward (Figure 7) per year, the green area ratio is high in the western part of the ward and low in the eastern part. This ratio is high in low-density areas and low in high-density areas.

Of the five areas in Setagaya Ward, the population density and the green area ratio of the Setagaya area (inside the blue frame) including Taishido was 17.48% with a population density of 18,135 people/km² in 2006. In 2011, the population density was 18,627 people/km² and the green area ratio was 16.67%, this is an increase of +492 people / km² and a decrease -0.81% of green space. It was expected that the redevelopment in the former National Children's Hospital ruins would affect the green area ratio. The reconstruction into three condominiums is projected to be able to achieve a green area ratio of 33% as "Setagaya Midori 33" in 2032. The target of the “Setagaya Ward Midori and Mizuno basic plan (2008-2017) was to achieve a population density of 20,220 people/km² in the Setagaya district in 2016 and an increase in green area ratio to 17.35%. Since 2011, the area saw an increase in population density of 1,593 persons / km², and in green area ratio of 0.68% [8].

Figure 4. The number of elderly people and the aging rate in each age in the 2nd and 3rd districts of Taishido, Setagaya.
Fiscal year 2006

Town distinction population density

| Density Range          | Color   |
|------------------------|---------|
| < 100 people/ha        | Lighter |
| 100–200 people/ha      | Medium  |
| >200 people/ha         | Darker  |

Green area ratio

| Area Ratio Range       | Color   |
|------------------------|---------|
| <10%                   | Lighter |
| 10–15%                 | Medium  |
| 15–20%                 | Medium  |
| 20–30%                 | Medium  |
| >30%                   | Darker  |

Figure 5. Population density and green area ratio in 2009, 2010 and 2016 in Setagaya ward [8]
5. Conclusion

The Ministry of Land, Infrastructure, Transport and Tourism conducted a survey on high-density areas vulnerable to earthquakes in 17 prefectures, comprising 197 districts and 5745 ha. The vulnerable condition in 824 ha was resolved in the fiscal year 2016, which is about half of the land with redevelopment status in Tokyo. Meanwhile, Japan will continue city-level measures such as redevelopment and joint rebuilding of the fire spread prevention areas to reduce the fire hazards in remaining redevelopment districts. Moreover, Japan seeks to implement district-level measurements such as the removal of vacant houses, and closing dead-end streets. Furthermore, the green infrastructure, which was decided by the Cabinet in 2015, will strengthen the role of land use for disaster prevention and reduction through greenery, and can reduce costs more than gray-infrastructure such as concrete structures.

The Tokyo Metropolitan Government, in cooperation with the ward, formulated a plan to promote the creation of a disaster prevention city in 1995 and 1996 and revised it repeatedly until today. The plan has designated the Setagaya ward as a participatory restoration-type project. This involves repeated workshops with residents, promoting earthquake resistance and fire-retardant private buildings if possible, and gradually increasing the disaster prevention of urban areas.

According to recent data, the number of elderly people increases annually, but the aging rate decreases after peaking in 2006. This is because the ratio of young people has increased in Setagaya due to the formation of high-quality homes with disaster prevention measures and access to central Tokyo. This was achieved through the redevelopment of the former National Children’s Hospital ruins in 2008 into three apartment buildings.

It is evident from Setagaya Ward that the green area ratio is generally high in areas with low population density and low in areas with high population density. However, in the Setagaya area, a comparison of the population density and the green rate in 2011 and 2016, shows that although the
population density in 2016 is higher than 2011, the green rate increased. The authors believe that this is due to the rebuilding of the ruins of the National Children’s Hospital and efforts to achieving a green area ratio of 33% in Setagaya Ward at the 100th anniversary of the district system in 2032. Green areas have various functions in the city, including an important role in disaster prevention. For example, greenery such as trees and forests can store rainwater and protect the city from inundation and floods. Also, rivers and parks help prevent the spread of fires, and green roads and roads with roadside trees are considered evacuation routes.

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