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AJG Library 8

Toshio Kikuchi · Toshihiko Sugai *Editors*

Tokyo as a Global City

New Geographical Perspectives

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Preface

Tokyo as a Global City: New Geographical Perspectives

Since the end of World War II, there has been a great concentration of people, goods, capital, and information in Tokyo, remodeling it as a modern metropolis, with all the characteristics as of a global city.

However, Tokyo is presently facing various challenges and conflicts due to the change and diversification of its industrial structure, technical innovation, the information revolution, and the diversification of social values. The recent energy revolution and the complex process of globalization complicate these issues still further. At present, Tokyo is standing at a critical juncture of the twenty-first century, facing its future as a fully developed global city.

When a new civilization develops rapidly over a short period of time, it tends to destroy or transform the civilization that already exists. Now, at the start of a new wave of information, it is timely to discuss Tokyo's function as a "city of the future" and suggest how it should be equipped for the requirements of a new era (Kikuchi et al. 2013).

In general, there are three geographical ranges in Tokyo, which may differ according to the situation or various conditions (Fig. 1). The most compact area among the three ranges is Tokyo city, which comprises 23 wards. Tokyo city excels in urban land use and has also become the central area of cosmopolitan Tokyo. Tokyo's second geographical range is the area covered by Tokyo Metropolis, an administrative division including government facilities and services. Finally, Tokyo's largest geographical range is Tokyo metropolitan area, which is formed by the cities, towns, and villages that accommodate over 1.5% of the employees and students who commute to Tokyo city for work and schooling.

The world has become borderless and huge volumes of capital, information, and goods can be exchanged in a moment on a global scale. The challenges of global cities in the twenty-first century are not only faced by Tokyo but also common to other cities, such as London, Paris, New York, and Shanghai, in both developed and developing countries. In this book of new regional geography, we will discuss Tokyo from a global point of view, focusing on the city's transition from a fishing village

Fig. 1 Three geographical ranges in Tokyo: Tokyo city, Tokyo Metropolis and Tokyo metropolitan area

to a global city. A geographical and regional approach is useful in exploring Tokyo's potential for further development. We aim to discover the changes to and diversification of human activities from multiple viewpoints. At the same time, we will review infrastructure improvements, and discuss how Tokyo should be prepared to deal with crises in the twenty-first century.

Regional geography, the branch of geography which studies regions, relies on two main approaches. The traditional approach addresses each geographical component/element of a region individually and in depth, in a descriptive, static manner. While the static regional approach can offer an exhaustively detailed account of a region, its descriptive-enumerative manner fails to stress the systematic links between various elements underlying a region's specific features. To offset such weaknesses of the static approach, a second, dynamic approach was devised in regional geography. This approach focuses on a region's specific phenomena and realities as a starting point, and then proceeds to identify the region's constituting elements and their interactions, which it records and explains in a systematic manner. The present volume, unlike its predecessors, relies on the dynamic approach and endeavors to offer a fresh account of Tokyo's new and diverse geographical realities, which are analyzed in a holistic, systematic manner, allowing identification of its specific features.

Tokyo has come a long way from its humble origins as a fishing village to become the prosperous metropolis of today. Built from scratch by Tokugawa Ieyasu, Edo became the *de facto* political center of Japan in 1603 (Fig. 2). Within a few decades, strict urban planning combined with policies to stimulate growth made Edo one of the world's most populous and thriving cities. Japan's official capital since 1868, the

Fig. 2 Edo Castle, constructed by Tokugawa Ieyasu (photographed by Kikuchi, July 2008). Geographically, Edo Castle is located in the central part of Tokyo and, today, it serves as the Imperial Palace

city suffered major destruction in the Great Kanto Earthquake in 1923 and in the air raids of 1945. Tokyo recovered quickly after the war, and an era of high demographic and economic growth followed. After the burst of the economic bubble in 1989, the economy suffered a protracted collapse that lasted for more than 20 years.

Its population, however, continued to grow: the metropolis had over 13 million inhabitants in 2013, and with 36 million people, Tokyo Metropolis is the most populous globally. It is also a major economic and financial hub, hosting the headquarters of many leading global and Japanese companies (Fig. 3). With one of the best public transportation systems and its reputation for safety, Tokyo is considered one of the world's most livable cities.

Tokyo remains a city of huge contrasts: while retaining its centuries-old cultural traditions, it is the stage for the most recent innovations in various fields. The metropolis offers a huge diversity of attractions, from cultural events to entertainment, dining (as the city with the most Michelin stars globally) and shopping; despite being considered the world's most expensive city (Fig. 4), it has been attracting an increasing number of foreign visitors.

However, Tokyo faces some critical socio-demographic and economic challenges that will affect its viability in the twenty-first century. Low birthrates (below 1%, compared with the national average of 1.24%), and an increasing share of elderly citizens combine to form one of the major challenges ahead. In the next 25 years, 30% of the population is projected to be aged over 65, and financial and institutional support for the elderly will place excess pressure on Tokyo's finances.

Fig. 3 Commercial district of Nihonbashi in Tokyo (photographed by Kikuchi, October 2012). Nihonbashi has been a commercial cluster since the Edo period. The headquarters of numerous wholesale, retail, and distribution businesses are located here

Fig. 4 Shinjuku, one of the busiest areas in Tokyo (photographed by Kikuchi, June 2006). Shinjuku is global and concentrated with many people and large amounts of goods, money, and information, which are transmitted to the world and vice versa

Fig. 5 Waterfront in Tokyo (photographed by Kikuchi, September 2014)

Social infrastructure and increased support for families with children are also necessary, in order to stimulate the birth rate and women's participation in the workforce (Kikuchi et al. 2014a).

Economic growth has been slow for the past decades; the more recent global economic crisis and the 2011 Tohoku earthquake, along with the Fukushima nuclear accident, followed the collapse of the bubble economy in a worst-case-scenario pattern. A new strategy to stimulate economic growth, deployed by the re-installed Liberal-Democratic Party (LDP), aims to overcome the consequences of the double disaster. Tokyo will benefit largely from the evolutions inspired by this strategy, provided it follows a stable path of sustainable development.

Multiple challenges lie ahead in strengthening urban synergies leading up to the 2020 Olympics, such as infrastructure upgrading and expansion, major redevelopment projects, improvement of the urban environment, etc. Therefore, a new development vision is critical for Tokyo's future. Through assimilation of the lessons learnt from the 2011 Tohoku earthquake, urban planning strategies should be reconsidered and priority should be given to enhance safety, increase energy self-sufficiency, and improve environmental sustainability (Fig. 5).

A revised 10-Year Plan (2007–2017) and the Tokyo Metropolitan Government's renewed urban strategy, "Tokyo Vision 2020," set the goals and the concrete policies to accomplish them. The new vision ambitiously aims to provide a roadmap to drive Japan forward.

The top priority remains strengthening the metropolis' disaster preparedness and enhancing safety in case of natural disasters (mainly seismic). Sustainable development is also a priority, with energy policies and projects aimed at making Tokyo a

Fig. 6 Nature walking trail at Tamagawa-Jousui in the western suburbs of Tokyo (photographed by Kikuchi, April 2007). There are plenty of green spaces in Tokyo's suburbs. These areas are used for recreational activities and as a measure to combat the heat island phenomenon

low-carbon society; a smart city of the future. Such evolutions coincide with projects to restore Tokyo's waterways and greenery, thereby addressing environmental concerns, and also aim to improve Tokyo's landscape amenity in order to attract more foreign tourists (Fig. 6).

Further, expanding transportation infrastructure and improving the synergy between air, land, and sea transportation systems, together with measures to set up comprehensive special development zones will enhance Tokyo's potential to attract foreign investment and will secure Tokyo's position as a key Asian economic hub.

A major social concern for most Japanese communities is the low birthrate and the aging population. Tokyo's new development vision promotes increased support for families, expanding the number of childcare facilities, senior citizen centers, and facilities for the disabled.

In the era of globalization, the education of globally minded citizens plays a vital role in strengthening international exchange and relations. Tokyo's new development vision addresses such concerns by proposing increased support for education abroad programs and for employment of young people. The 2020 Olympics will provide an impetus for Tokyo to reinforce efforts for increased international exchanges; the Games will also provide the stage for its newly acquired international status.

The geographical diversity of Tokyo's territory is the backdrop for its rich biodiversity, which requires increasing conservation efforts. Reviewing the current status of the natural environment and biota, many geographers and ecologists highlight the diversity of species, ecosystems, and landscape types of the metropolis, but also stress the conservation priorities it faces in the future.

Fig. 7 Satoyama conservation activities in the western suburbs of Tokyo (photographed by Kikuchi, January 2005). New residents, along with the local farming families, carry out conservation activities to sustainably maintain the remaining natural and green areas of Tokyo

The intensity of pressures triggering continuous biodiversity loss in the metropolitan area is increasing. While successful nature conservation efforts have managed to maintain biodiversity, they have also led to the emerging problem of human wildlife conflict in some urban areas. A decrease in urban population also causes changes in wildlife habitats, and it is necessary for Tokyo to reconsider the boundary between human society and wildlife and the appropriate way to accomplish a harmonious coexistence between people and nature (Fig. 7).

The Conference of the Parties (COP 10) Convention on Biological Diversity, held in Nagoya in 2010, has had positive impacts on the policies and practices for conserving and managing biodiversity in Japan. In Tokyo, further efforts to promote public cooperation are the key to establishing an urban planning framework for the sustainable management of biodiversity from now on.

At present, Tokyo is confronted with a broad range of challenges, and in the following years and decades, the city will have to devote major efforts to overcoming such barriers and developing into an urban model for the twenty-first century. The studies in this regional geography volume offer valuable insights into the efforts to re-shape Tokyo as a global city of the future; a global economic, cultural, and touristic hub.

As Japan's largest urban center, Tokyo concentrates more than half of the country's key controlling functions. Some studies in this volume stress the need for decentralization and explain the disadvantages of centralization, including the potential risks

Fig. 8 Haneda Airport, the gateway to Tokyo’s sky (photographed by Kikuchi, November 2010). Haneda Airport operates international and domestic flights, and provides easy access to central Tokyo. It has become a main access point in the city

associated with a massive earthquake, which could disable vital functions of the metropolis and halt the functioning of the entire nation. To improve the efficiency of the country’s emergency measures, Tokyo's capital functions should be decentralized.

Tokyo’s transportation system is one of the busiest in the world. While the streamlining of railway and expressway networks has increased synergies and improved overall convenience, airport and seaport systems lag behind (Fig. 8). In the following decades, improved planning and an integrated management system for air and sea transportation will be the key to future socio-economic growth.

Waste management represents one of the biggest challenges confronting Japanese cities. In this volume, Tokyo’s solid waste management system, with its two distinct components, is examined. For the 23 wards of Tokyo, the metropolitan government promoted the district self-sufficiency principle and local incineration facilities. Post 2000, responsibility for municipal solid waste shifted to the wards, resulting in differences in separating and recycling waste. As of the 1990s, through policies to reduce waste generation and incinerate plastic waste, the capacity of waste disposal sites was increased within a few decades.

From a historical perspective, improving the infrastructure of production and supply has been the preferred solution to satisfy Edo’s increasing food demand, which enabled the development of suburban agriculture and the expansion of food-supply networks, first domestically and then globally. In the twentieth century, such developments favored mass production and large-scale producing areas, but disad-

Fig. 9 Urban agriculture in Nerima District, Tokyo (photographed by Kikuchi, December 2009). Urban agriculture is conducted on a small scale, but is an important economic activity to provide fresh and safe vegetables to urban residents. Farm stands for the direct sale of vegetables are operated in these areas

vantaged minor producing areas. The recent weakening of food supply infrastructures in the metropolitan and urban fringes indicate the importance of optimizing and responding to the recent popularity of alternative added-value food, which favors quality in the safety, freshness, and traceability of food supplied (Fig. 9).

In terms of Tokyo’s infrastructure expansion, the legacy of the 1964 Olympic Games remains mixed, with major progress in both quality and coverage being overshadowed by damage to the historical landscape of the central city. It is expected that the 2020 Olympics will contribute to the reconsideration of Tokyo’s urban planning priorities in the twenty-first century, and that sustainable approaches will prevail in the planning of the Tokyo Waterfront, where the main facilities will be built.

The range of Tokyo's big-city functions and activities, in other words, the range of daily economic and social activities, roughly correspond to an area confined by the Metropolitan Inter-City Expressway. It is an area of highly integrated business functions and knowledge-intensive activities, which generate wealth.

The synergetic nature of Tokyo’s infrastructure, boasting the world’s most convenient rail network and relatively smooth road traffic, makes Tokyo's management both unique and practical. This system will allow Tokyo to host the 2020 Summer Olympics right in the heart of the city. In the years leading up to the Olympics, a shift in priorities is desirable, from an industry-focused metropolis towards a new model of a mature society, in which quality of life is enhanced. Improvements and progress are also expected in the promotion of a barrier-free society (Kikuchi et al. 2014b).

The geophysical, geological, and geomorphological studies on Tokyo's location and foundations have clearly demonstrated that the Metropolis is situated in a highly mobile tectonic area. To overcome its natural barriers, large scale operations of land consolidation, farmland development, and the creation of a system of water transportation have been carried out over the centuries.

Through such human efforts to domesticate nature, and capitalizing on its geographical position at the center of a wide plain and at the intersection of important flows, Edo/Tokyo has increasingly concentrated people, physical assets, capital, and information, continually growing into a metropolis.

As one of the world's largest metropolitan areas, a major problem Tokyo must manage is its geographical position in a highly mobile tectonic area, necessitating urban planning strategies to address natural hazards. Such new strategies should capitalize on Tokyo's long record of experiences in dealing with disasters.

Relatedly, comparatively wide natural areas still survive in Tokyo, and their rational use and conservation should remain one of the priorities of future urban planning. Reconsideration of the traditional lifestyle of Edo, one of harmonious coexistence between nature and society, should be the basis of a new, innovative urban planning philosophy for the twenty-first century, centered on the values of coexistence with nature.

We strongly believe it is Tokyo's mission to lead the way in promoting such values globally into the twenty-first century.

Hachiohji, Japan Toshio Kikuchi

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Contents

Chapter 1
Late Quaternary Landform Development of the Kanto Plain

Toshihiko Sugai, Hiroko Matsushima (Ogami), and Takeshi Ishihara

Abstract The Kanto Plain is the tectonically active setting of the Tokyo metropolitan area. It is characterized by widespread uplands, consisting of Pleistocene fluvial, marine sediment, tephra layers, and narrow lowlands filled with thick Holocene alluvium. This landscape owes its origin to the interaction of basin-forming movements, eustasy, erosion, and sedimentation during the Quaternary Period. Marine transgressions in marine isotope stages (MIS) 11, 9, and 5.5 repeatedly overlapped the land, producing Paleo Tokyo Bay, with its wide mouth facing the Pacific Ocean to the east. In contrast, the Holocene (MIS 1) marine transgression was limited to the river valleys incised since MIS 4, and instead of Paleo Tokyo Bay, Modern Tokyo Bay has appeared. Modern Tokyo Bay, which opens to the south, resulted from the combination of: (1) a lower sea level in MIS 1 than in MIS 5.5; (2) tectonic uplift of the Kanto Plain, especially the east side; and (3) the accumulation of fluvial sediment and tephra since MIS 5.4.

Keywords Lowland · Upland · Marine transgression · Sea-level change · Kanto basin-forming movement · Paleo Tokyo Bay

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1.1 Introduction

The Japanese archipelago is composed of five island arc-trench systems (Fig. 1.1a), of which the Northeast Japan, Southwest Japan, and Izu-Ogasawara arc–trench systems meet near the Kanto Plain, the largest plain in Japan (Fig. 1.1b). The 17,000 km^2 watershed of the Kanto Plain includes metropolitan Tokyo and the adjoining prefectures of Kanagawa, Saitama, Chiba, Ibaraki, Tochigi, and Gunma (Fig. 1.2). These political entities encompass a population greater than 42 million (2014), of whom more than 80% live in the Kanto Plain. The Kanto Plain is, thus, the world's most populous metropolitan area.

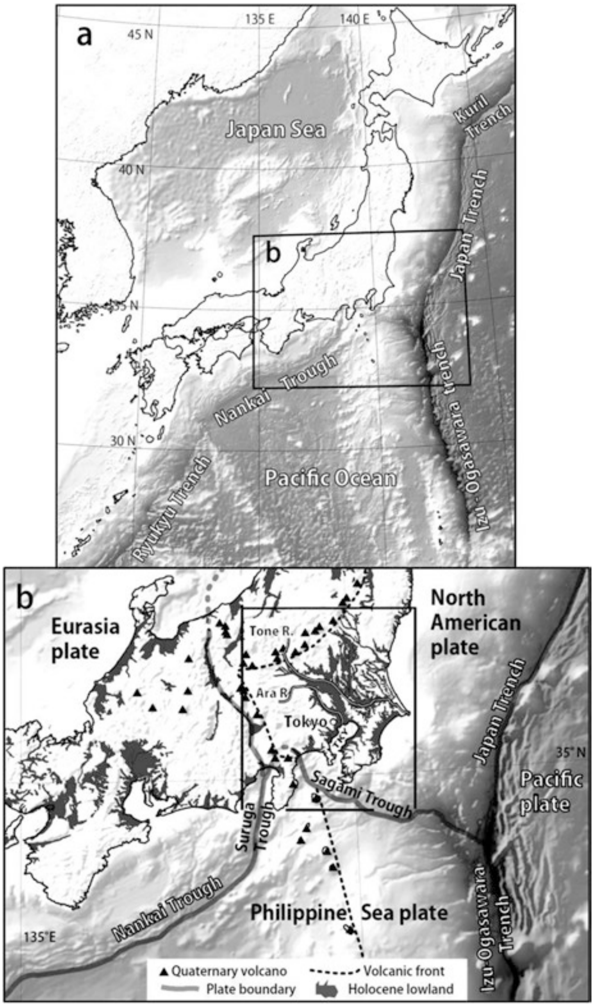

Fig. 1.1 Topography of (**a**) Japanese islands and surrounding areas, and (**b**) tectonic setting of central Japan. (**b**): Modified from Sugai et al. (2013)

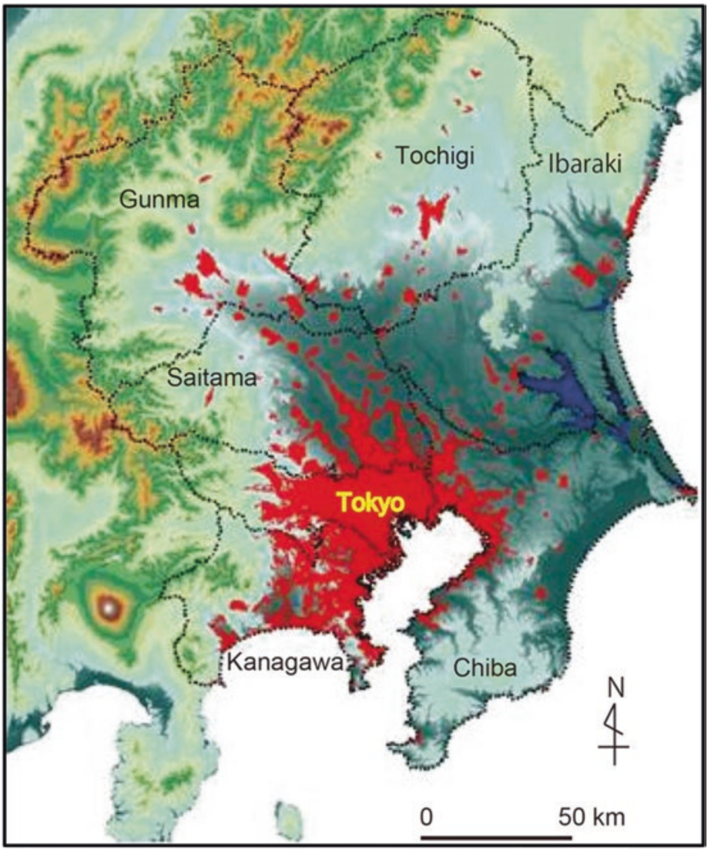

Fig. 1.2 Topography of the Kanto region; location shown in Fig. 1.1b. Densely inhabited district areas (population density over 4000/km^2) are colored red

The Kanto Plain is a rectangular area bounded by the Yamizo, Ashio, Echigo, and Kanto Mountains on the north and west, and the Pacific Ocean on the east and south (Fig. 1.3). Along its east coast are sandy beaches with ridges, such as Kashimanada and Kujyukurihama, while rocky shores typify the south coast. In the central part of the south coast, Tokyo Bay extends deep into the Kanto Plain via the Uraga Channel, between the Boso and Miura Peninsulas.

The geomorphology of the Kanto Plain is characterized by well-developed Pleistocene uplands that formed mainly during MIS 5, the last major interglacial period (Fig. 1.3). The uplands are dissected by river valleys, including those of the Tone, Ara, Kinu, and Tama Rivers. The abundant sediment carried by these rivers expanded the deltaic lowlands during the mid- to late-Holocene.

This chapter explains when and how the landscape of the Kanto Plain was established, focusing on cyclic marine transgressions during the last 430,000 years coupled with long-term tectonic activity, together called the Kanto basin-forming movements (Yabe and Aoki 1927).

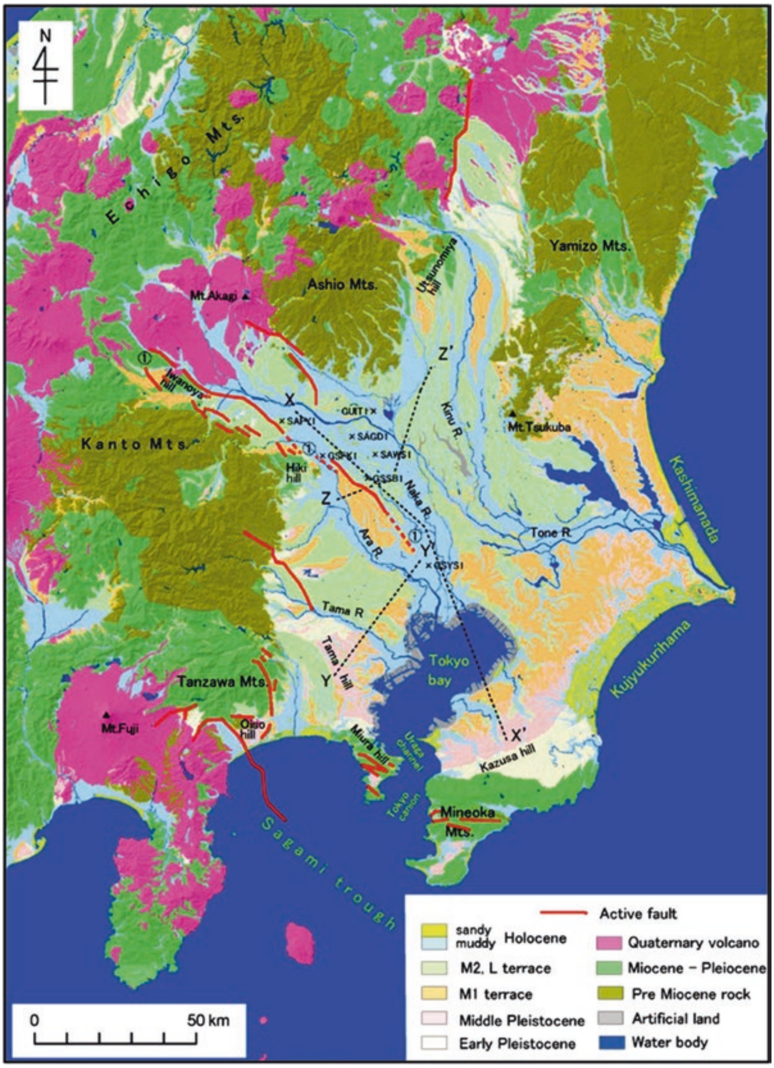

Fig. 1.3 Simplified geologic and geomorphic map of the Kanto region, modified from the Geological Survey of Japan (2015) and Sugiyama et al. (1997). Active faults of the Kanto region are shown in red (Headquarters for Earthquake Research Promotion 2015). ① Fukaya fault systems

1.2 Tectonic Setting

The Kanto Plain is surrounded by complex convergent plate boundaries and two triple junctions (Fig. 1.1b). Along the Japan Trench, the Pacific Plate subducting below northeastern Japan gave rise to the northeast Japan volcanic front along the west and northwest sides of the Kanto Plain. Because of the windward position of the volcanic front, tephra beds from these volcanoes have been deposited in the plain throughout the Quaternary Period.

Off the eastern coast of the Kanto Plain lies a wide continental shelf, and the Japan Trench is about 150 km offshore (Fig. 1.1b). Off the southern coast, a narrow shelf gives way to a steep continental slope descending to the Sagami Trough. Along the Sagami Trough and Japan Trench, the Philippine Sea Plate and Pacific Plate respectively are subducting beneath the Kanto Plain. Consequently, the southern and eastern margin of the Kanto Plain has been uplifted as part of the Kanto basin-forming movement (Yabe and Aoki 1927; Uesugi et al. 1977; Kaizuka 1987) and the basin depocenter has migrated toward the northwest since the Pleistocene (Naruse 1961; Kikuchi 1980; Suzuki et al. 2011). The collision of the Izu Peninsula between 3 and 0.5 Ma changed the subduction direction of the Philippine Sea Plate from north to northwest (e.g., Nakamura and Shimazaki 1981; Seno et al. 1989; Takahashi 2006). This event also influenced the Kanto basin-forming movements, as well as the activity of inland faults.

In the Kanto Plain, several active reverse faults, oriented NW-SE, run roughly parallel to the Sagami Trough about 20 km apart (Fig. 1.4), a consequence of the compressional stress field associated with the collision of the Izu Peninsula (Matsuda 1978). Of these, the Fukaya fault system is the longest, with a vertical slip rate of about 0.5 mm/year near its midpoint (Mizuno et al. 2004; Watanabe 2007), and its downthrown northeastern side has made space to accommodate thick upper Pleistocene and Holocene sediments (Sugiyama et al. 2003; Sugai et al. 2007). The northeastern side of the Fukaya fault system is the youngest depocenter of the Kanto basin, along with the northern part of Tokyo Bay.

1.3 Geomorphology and Subsurface Geology of the Kanto Plain

Pleistocene tephra layers enable us to date the geomorphic surfaces in the Kanto Plain (e.g., Kaizuka 1958; Machida 1973; Sugiyama et al. 1997; Suzuki 2012) (Fig. 1.4). The geomorphic surfaces are closely related to the subsurface geology, with both tending to become younger from the margin to the center of the plain. Because the Kanto Plain is an active sedimentary basin, the central part has subsided while the marginal part has been uplifted (Kaizuka 1987; Nakazato and Sato 2001).

The Yamizo, Ashio, and Kanto Mountains to the north and west of the Kanto Plain expose pre-Miocene basement rocks. The Tanzawa and Mineoka Mountains to the south expose Miocene rocks that include serpentinite. Along the foot of these mountains, Neogene and early Pleistocene rocks compose numerous hills: Utsunomiya, Iwanoya, Hiki, Tama, Miura, Kazusa, and others. The eastern part of the Kanto Plain has large terrace surfaces composed of marine sediments correlated with MIS 5.5. The west-central part of the plain contains terrace surfaces (such as the Omiya Upland) composed of fluvial sediments dating from MIS 5.4 to MIS 4,

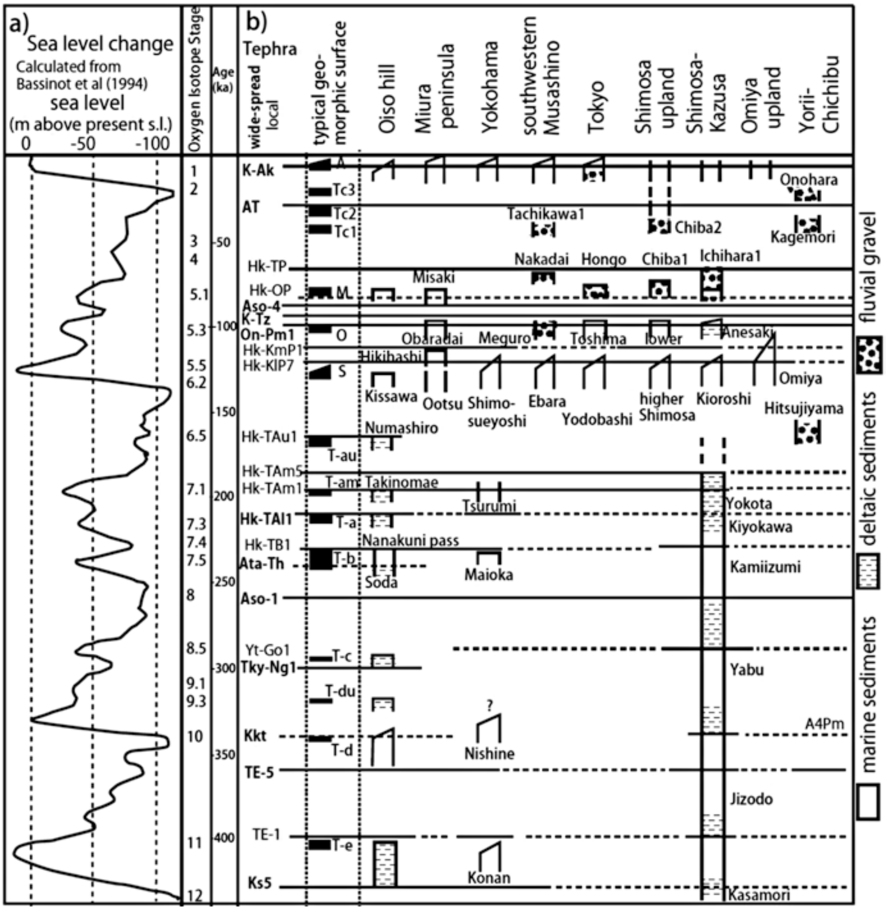

Fig. 1.4 Diagram showing eustatic sea-level changes, marine isotope stages, major tephra layers, and geomorphic surfaces of the Kanto Plain. **b**) S (Shimosueyoshi) and O (Obaradai) surfaces are shown as M1 in Fig. 1.3. M (Misaki) and Tc (Tachikawa)1 -Tc3 group shown as M2 and L in Fig. 1.3 (Simplified from Machida (2008) and Sugai et al. (2013))

which partly cover MIS 5.5 marine surfaces (Fig. 1.3). The northern and western edges of the plain have MIS 3 to 2 fluvial surfaces, which continue downstream to incised valleys filled with Holocene sediment. Holocene fluvial sediments also form alluvial lowlands along the rivers, in particular around the cities of Gyoda and Kazo in the central part of the Kanto Plain (Endo et al. 1982; Hirai 1983; Endo 2015).

Although the concentric patterns in the surface geology and geomorphology of the Kanto Plain reflect the Kanto basin-forming movements, this pattern does not account for the widespread distribution of MIS 5 geomorphic surfaces. The next section explores the relationship between these landforms and paleo-shoreline changes associated with the marine transgressions in MIS 11, 9, 7, 5.5, and 1 (Sprart and Lisiecki 2016).

1.4 Marine Transgressions

1.4.1 Reconstructing Paleo-shorelines

The evidence for ancient shorelines in and around the Kanto Plain has been compiled over the last few decades. The nature of that evidence differs in different parts of the plain. In uplifted areas, raised shorelines dating from the maximum transgressions of MIS 11, 9, 7, and 5.5 have been identified based on the age and location of the shoreline angle preserved on marine terrace surfaces (Koike and Machida 2001).

In subsided areas, marine deposits have been identified in many borehole samples, in the form of molluscan fossils, marine diatoms, high electrical conductivity of core sediments, and high sulfur content (e.g., Geological Research Group of Central Kanto Plain 1994). Marine deposits have been correlated between boreholes based on tephra layers, pollen assemblages, and horizontal continuity (e.g., Nakazawa and Nakazato 2005; Matsushima et al. 2009; Sugai et al. 2013; Naya et al. 2014) (Fig. 1.5). The inland limits of these correlated marine deposits have been identified as paleo-shorelines from the marine transgressions (Matsushima et al. 2006, 2010; Sugai et al. 2013) (Fig. 1.6).

Along the north and northwest margins of the Kanto Plain, identification of marine sediments is difficult because thick beds of alluvial gravel were deposited there (e.g., SAFY1 core in Fig. 1.5) instead of inner bay mud. Thus, the reconstructed shorelines in Fig. 1.6 show only the minimum extent of the sea. However, the transgressions are not severely underestimated because the relatively steep slopes of the fan surfaces (greater than 0.2%) allow the position of the paleo-shoreline to be fairly well estimated.

1.4.2 Paleo-Shorelines from Recent Marine Transgressions

MIS 11: Reconstructed paleo-shorelines show that the Paleo Tokyo Bay, opening to the Pacific Ocean, was established at the time of the marine transgression in MIS 11 (Fig. 1.6). The bay extended nearly to the foot of the Kanto and Ashio Mountains, and reached the alluvial fans of the paleo Tone and Ara Rivers. The exact position of the shoreline is not well determined because marine sediments are difficult to identify in the coarse deposits typical of high-energy sedimentary conditions. The MIS 11 marine transgression was the largest of the five most recent transgressions. MIS 11 marine sediments can be identified throughout the central and northwestern Kanto Plain, allowing us to reconstruct their distribution on the basis of their elevations (Fig. 1.7).

MIS 9: Sedimentary and topographic evidence shows that the marine transgression in MIS 9 apparently extended as far as the MIS 11 transgression (Figs. 1.6 and 1.7). In northeastern Saitama Prefecture, however, the estimated water depth of the Paleo

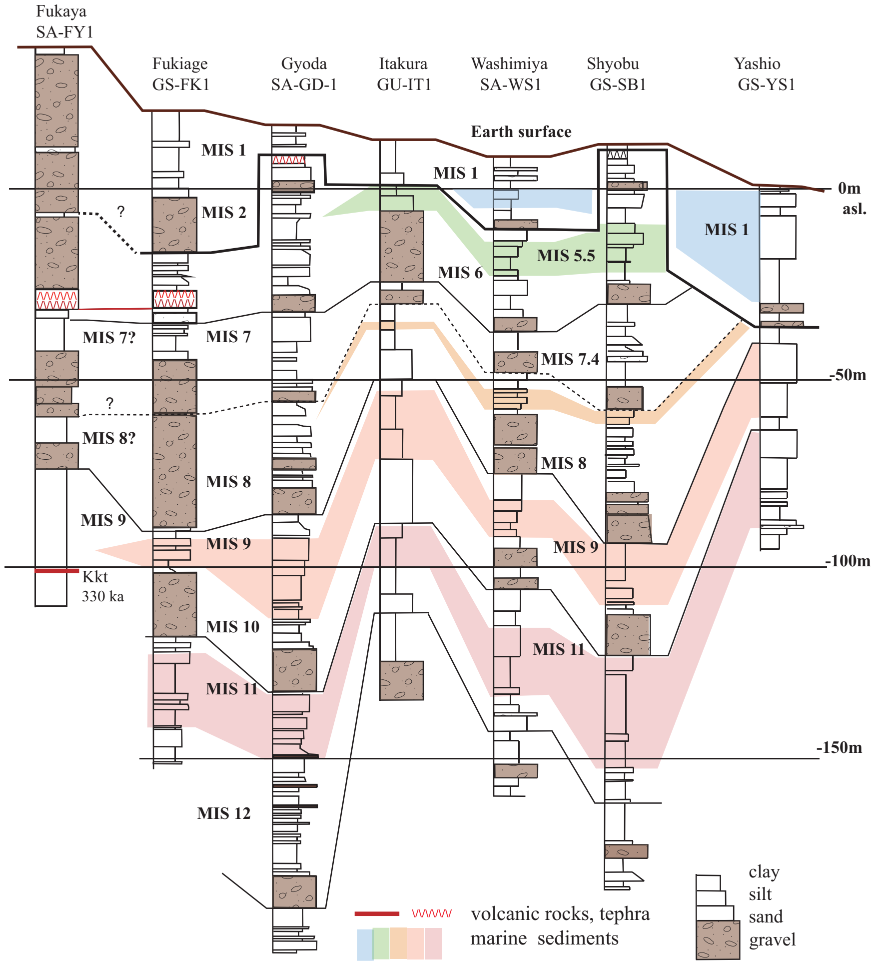

Fig. 1.5 Geologic columns of boreholes; locations shown in Fig. 1.3 (Sugai et al. 2013). SA-FY1 modified after Mizuno et al. (2004), GS-FK1 and SA-GD1 modified after Matsushima et al. (2006), GS-SB1 modified after Yamaguchi et al. (2009), and GS-YS1 modified after Sakata et al. (2011)

Tokyo Bay was shallower in MIS 9 than in MIS 11, according to analyses of sediment facies (Matsushima et al. 2009) and ostracod assemblages (Irizuki et al. 2011). Thus, this transgression is considered to be the second largest among the last five.

MIS 7: Three transgressions occurred in MIS 7 (MIS 7.5, 7.3, and 7.1), forming three marine terrace levels that are preserved in areas of rapid uplift (Fig. 1.3). The MIS 7.5 transgression was the largest of the three, and it is identified from marine deposits in the central Kanto Plain (Fig. 1.5). Thus, the MIS 7 paleo-shoreline (Fig. 1.6) is that of MIS 7.5, although the available age data do not preclude the

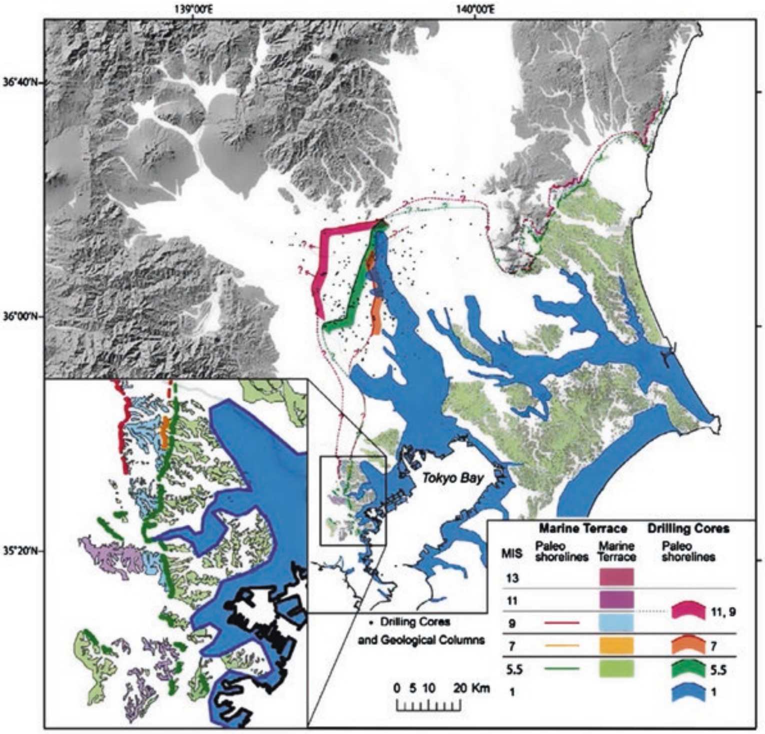

Fig. 1.6 Paleo shorelines and marine terraces in the Kanto Plain (Sugai et al. 2013)

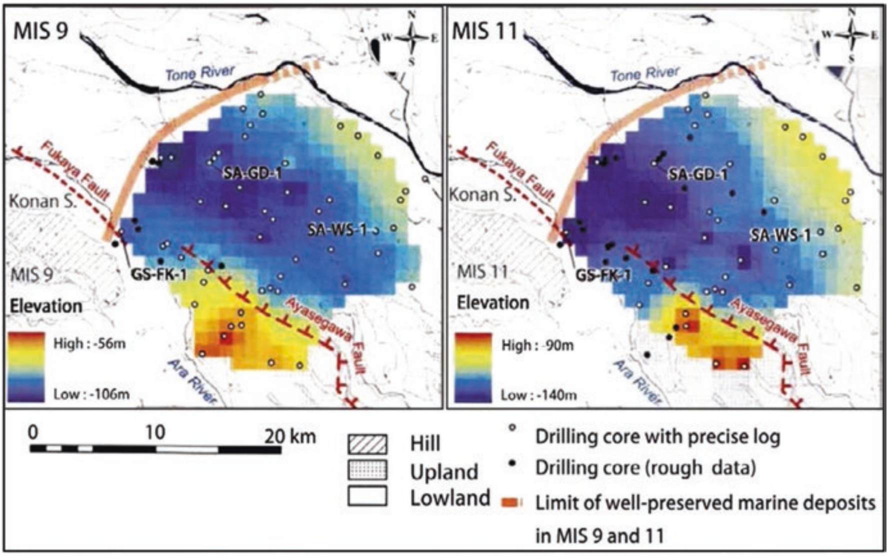

Fig. 1.7 Elevation of buried depositional surfaces of marine sediments of MIS 9 (left) and MIS 11 (right) (Sugai et al. 2013)

presence of MIS 7.3 or 7.1 shorelines. Despite the ambiguity, we can confidently assert that the MIS 7 marine transgression was the second smallest of the last five.

MIS 5.5: In marginal parts of the Kanto Plain, such as Yokohama and the northeast Pacific coastal area, MIS 5.5 paleo-shorelines are shown in detail (Koike and Machida 2001). However, they are unclear in the central and northwestern parts of the plain because MIS 5.5 marine surfaces were modified by fluvial sedimentation and erosion after MIS 5.4. Figure 1.8 shows that MIS 5.5 marine deposits are covered by around 20 m of fluvial and eolian deposits; therefore, determining the exact elevation of MIS 5.5 shorelines is difficult. In terms of areal extent, we can say that the MIS 5.5 transgression was the third largest of the last five.

MIS 1: Toki (1926) mapped paleo-shorelines from MIS 1 based on the distribution of shell mounds formed in the Jomon Period (from ca.12,000 to 2400 years ago). The paleo-shorelines reached far up the valleys of the Tone, Kinu, and Ara Rivers (Endo et al. 1982). The innermost portion of the bay extended 80 km beyond its present extent, reaching the north-central part of the Kanto Plain during the maximum transgression about 7000 years ago (Fig. 1.6). At that time, the present Tokyo Bay, with its narrow mouth facing south to the Pacific Ocean, was first established.

1.4.3 Marine Transgressions and the Demise of the Paleo Tokyo Bay

The paleo-shoreline evidence shown in Fig. 1.6 suggests that the last five marine transgressions in the Kanto Plain generally decreased in magnitude. The only exception to this trend is the MIS 5.5 transgression, in which the eustatic sea level was exceptionally high (Fig. 1.3 of Bassinot et al. 1994; Blanchon et al. 2009). This decreasing trend very likely reflects the long-term tectonic uplift of the eastern and southern parts of the plain.

The marine transgressions in MIS 11, 9, and 5.5 extended the Paleo Tokyo Bay broadly over the surrounding land surfaces. In contrast, the MIS 1 transgression was limited to the incised river valleys that had developed during the low sea level of the last glacial period. The modern Tokyo Bay, with its restricted southern outlet, appears to be associated with this transgression. The marked decrease in the magnitude of the transgressions from MIS 5.5 to MIS 1 is partly the result of long-term uplift and partly because the sea-level rise was smaller in the MIS 1 transgression than in that of MIS 5.5. Furthermore, the accumulation of fluvial and volcanic deposits during the last glacial period had built up the land surface, restricting the MIS 1 transgression to the incised river valleys.

The result of these factors was to preserve the widespread geomorphic surfaces formed during the MIS 5 transgression from degradation by the subsequent MIS 1 transgression.

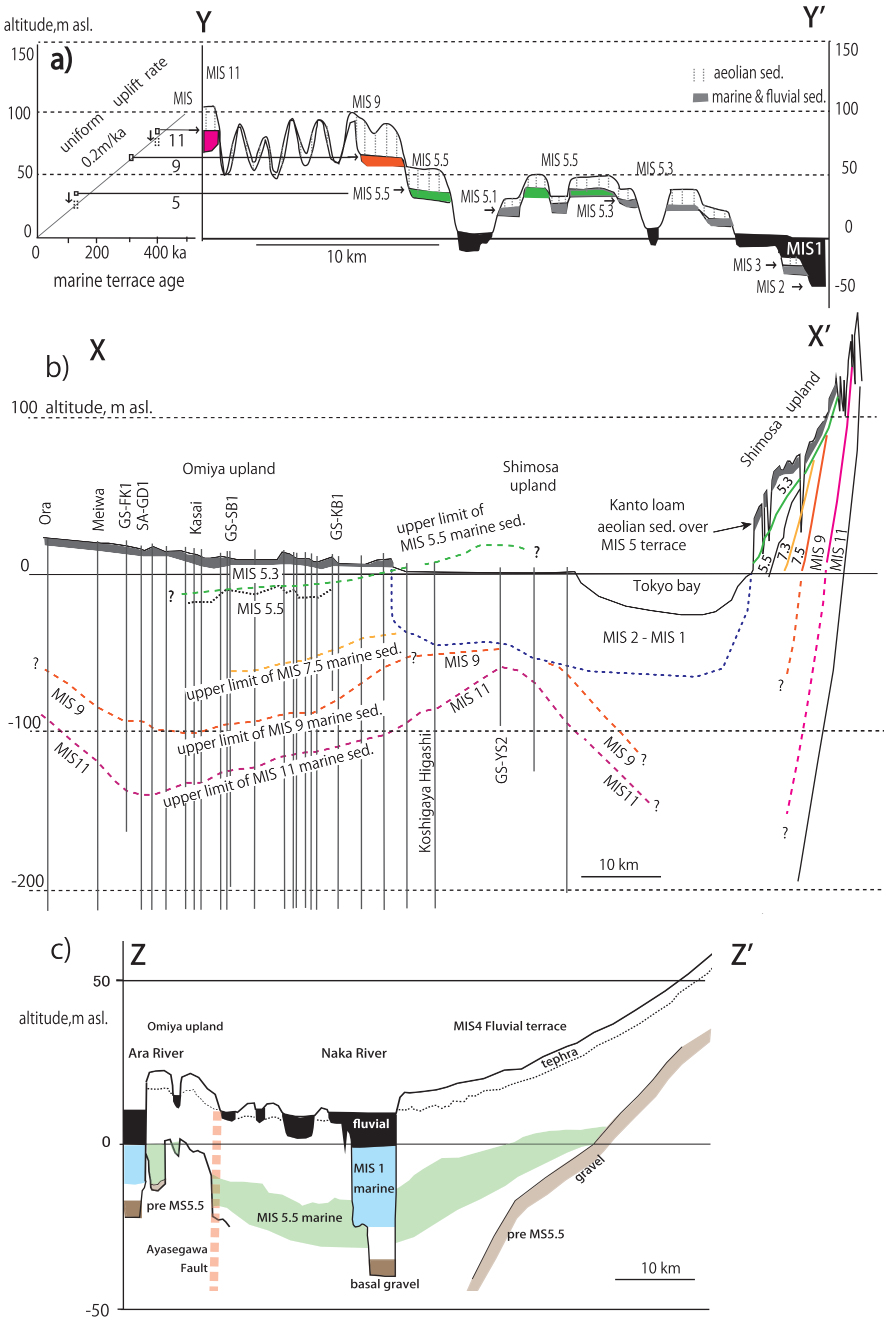

Fig. 1.8 Geomorphic and geologic cross-sections across the central part of the Kanto Plain. Location of profiles shown in Fig. 1.3. (**a**) Yamanote-Tama area modified from Sugai et al. (2013); after Kaizuka and Suzuki (1992). The figure to the left is an elevation-age model of MIS 5.5, 9, 11 marine terrace levels. Adjacent MIS 5.5 and 11 terrace levels suggest that sea-levels in MIS 5.5 and 11 were higher than the present sea-level (Fig. 1.4a). (**b**) NNW-SSE cross-section, from Sugai et al. (2013). (**c**) NE-SW cross-section. Central part of the section shows the depocenter of the Kanto Plain

1.5 Change of Drainage Systems on the Kanto Plain

1.5.1 Buried Landforms on the Kanto Plain

Drainage patterns potentially reflect the history of landform development, particularly in the humid climate of Japan, because rivers with abundant water discharge tend to maintain their position despite a land uplift or sea-level fall. Conversely, marine transgression–regression cycles may serve to reset drainage patterns. During transgressions, marine sediments may cover up previous drainage systems and create a flat seafloor. During the subsequent regressions associated with glacial periods, new channels may be inscribed on the emergent seafloor. These channels may persist through subsequent transgressions, particularly if they incise deep valleys. Reconstructing ancient drainage systems and comparing them with the present ones is an important contribution to understanding the long-term geomorphic history of coastal areas.

Buried fluvial landforms developed in glacial periods are harder to study than interglacial landforms. This is partly because the landforms produced by fluvial erosion and deposition during glacial periods may be concealed by younger sediments, and partly because these geomorphic surfaces tend to be eroded during transgressions. Thus, the following discussion should be considered tentative.

In the Japanese islands, sea-level fall during the last glacial period triggered river incision near the coast, mainly because the islands are surrounded by steep continental slopes (Umitsu 1981; Kubo 1997; Honda and Sugai 2011; Sugai et al. 2016). In the Kanto Plain, the Paleo Tokyo River (Sugimura and Naruse 1954, 1955; Kaizuka et al. 1977) became deeply incised during the last glacial period, and these incised valleys are buried beneath younger alluvium (Fig. 1.9; Ishihara et al. 2011). In the Paleo Tokyo Bay area, buried drainage systems from MIS 6 are preserved beneath the MIS 5 sediments (Kikuchi 1980; Nakazawa and Endo 2002; Nakazawa and Tanabe 2011). Thus, we have been able to reconstruct the paleo drainage systems from MIS 6 and MIS 2 for comparison with the present drainage system (Fig. 1.10).

1.5.2 Paleo Drainage Systems Since MIS 6

The paleo drainage system from MIS 6 displays a mainly eastward flow direction toward the Paleo Tokyo Bay, although the reconstruction is incomplete. In contrast, much of the drainage system from MIS 2 is oriented southward toward the present Tokyo Bay. Uplift associated with subduction of the Pacific Plate beneath the Kanto Plain has raised the east side of the plain and the floor of the Paleo Tokyo Bay and tilted them westward (Nakazato and Sato 2001; Sugai et al. 2013). After the maximum marine transgression in MIS 5.5, long barrier islands were formedacross the mouth of the Paleo Tokyo Bay (Okazaki and Masuda 1992). As new drainage

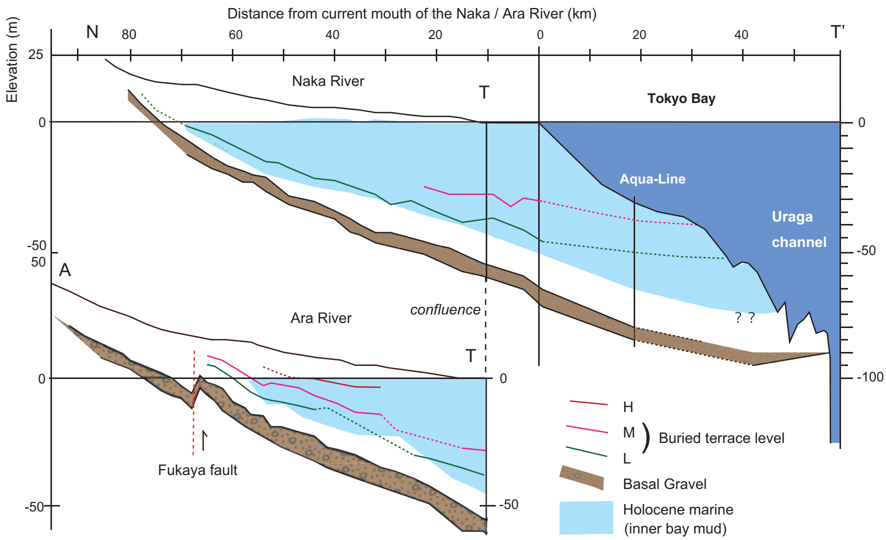

Fig. 1.9 Geologic and geomorphic longitudinal sections along the Naka River Valley (top) and Ara River Valley (bottom). Shading indicates marine sediments. Simplified and modified after Ishihara et al. (2011, 2012). Location shown in Fig. 1.6

systems appeared on the bottom of the emerged Paleo Tokyo Bay, these barriers directed river flows to the south. In other words, after MIS 5.5, the present Tokyo Bay captured the drainage systems of the central and eastern parts of the Kanto Plain.

Uplift associated with subduction of the Philippine Sea Plate has affected the southern part of the Kanto Plain. The uplift rate exceeds 2 mm/yr. in the southern part of the Boso and Miura Peninsulas (Fujiwara et al. 2004), causing notable northward tilting. Although this uplift must have hampered river flow to the south, just as uplift affected the eastern part of the plain, Tokyo Bay has, nevertheless, become the major outlet of the Kanto Plain. The difference between the two regions may be the relatively steep offshore slope on the southern side of the plain, as the Sagami Trough is close to the southern shore while the Japan Trench is far from the eastern shore (Fig. 1.1b). Sea-level drops may promote river incision more effectively on the steeper of the two slopes. The result is that, today, water and soil nutrients from the Kanto district are directed into Tokyo Bay.

The modern drainage system has been modified by human alterations to the Tone River, which started in 1594. In the absence of human activities, the drainage pattern of today should be almost the same as that in MIS 2. Arguably, the alterations have changed the drainage system from MIS 2 back to that in MIS 6.

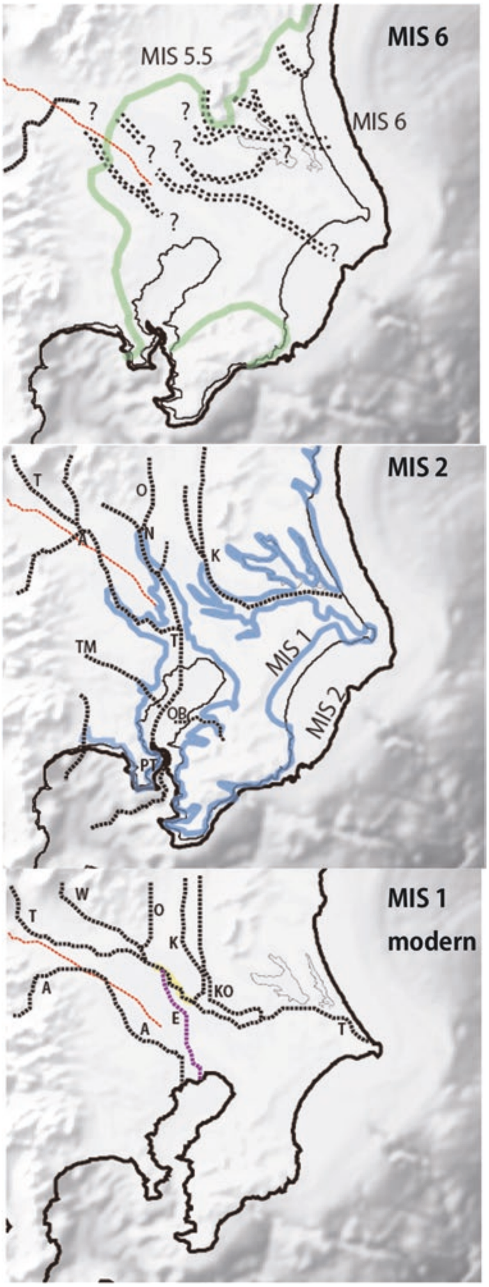

Fig. 1.10 Major river channels of the Kanto Plain in MIS 6, 2, and 1. Green and blue lines show the shoreline of MIS 5.5 and the MIS 1 marine transgression, respectively. *A*, Ara River, *K*, Kinu River, *KO*, Kokai River, *O*, Omoi River, *T*, Tone River, *TM*, Tama River, *W*, Watarase River

1.6 Valley Incision and Filling Associated with Sea-Level Changes in the Central Kanto Plain

This section focuses on the buried river valley in the central Kanto Plain, where the Ara and Naka Rivers now run (Ishihara et al. 2011, 2012). The Naka River (Old Tone River) flows into Tokyo Bay, the southern depocenter of the Kanto Plain, through the northern depocenter (Figs. 1.6 and 1.10). In the mid- to late-Holocene, the Tone and Watarase Rivers joined the Naka River (Hirai 1983; Tanabe et al. 2015) near the northern depocenter, before their diversion to the east was started by public engineering works in 1594. The Ara River crosses the Fukaya fault system from the downthrown to the upthrown side, joining the Naka River where they both flow into Tokyo Bay. The Naka and Ara Rivers were controlled by the same base-level changes during the late Pleistocene.

The average gradients of the buried valley bottoms of the Naka and Ara Rivers are steeper than the present river beds (about 0.1% compared to about 0.03%), and they deposited thick alluvium far from their present mouths (Fig. 1.9). The floor of Tokyo Bay slopes still more steeply at around 0.15%; beyond the bay, the seafloor slope exceeds 3%. This arrangement strongly suggests that the Naka and Ara Rivers deeply incised the Kanto Plain and the exposed floor of Tokyo Bay during sea-level lows in the late Pleistocene. It also appears that the thick valley fills and thick alluvium in upstream areas reflect tectonic subsidence associated with the Kanto basin-forming movements. It is worth noting that the great thickness of alluvium in the Tokyo Lowland (more than 50 m) increases the risk of liquefaction and land subsidence.

The Ara River has several buried terraces on the upthrown (downstream) side of the Fukaya fault system. Their presence suggests that fault activity coupled with sea-level lowering triggered successive steps of incision that left these terraces. In contrast, the buried valley of the Naka River has a relatively wide floor and no terraces, probably reflecting conditions in which tectonic subsidence and fluvial sedimentation offset the effect of lower sea levels. Furthermore, the inland limit of marine sediments differs between the two river valleys: seawater invaded farther up the Naka River Valley, and the timing from marine transgression to regression was later there than in the Ara River Valley. Such differences imply that global sea-level changes affect river valleys differently, depending on local tectonic and geomorphic conditions.

1.7 Conclusion

The Kanto Plain is characterized by widespread uplands, whose deposits include a series of Pleistocene tephra layers, and narrow lowlands filled with thick alluvium. This landscape was formed by the combination of basin-forming movements, eustasy, erosion, and sedimentation during the Quaternary Period. While the marine transgressions in MIS 11, 9, and 5.5 produced Paleo Tokyo Bay, opening eastward to the Pacific Ocean, later transgressions were limited to river valleys incised since MIS 4. Paleo Tokyo Bay vanished after MIS 5, giving way to the relatively narrow, south-facing, modern Tokyo Bay. This change resulted from the combination of: (1) lower sea-level highs since MIS 5.5; (2) tectonic uplift of the Kanto Plain, especially the east side; and (3) the accumulation of fluvial sediment and tephra since MIS 5.4.

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Chapter 2
History and Future of Volcanic Disasters in and Around the Tokyo Metropolitan Area, Central Japan

Takehiko Suzuki

Abstract This chapter reviews historical volcanic disasters that affected the Tokyo metropolitan area and its surroundings in Central Japan. It discusses the danger of volcanic disasters that will occur in the future. The 1707 (Hoei) eruption of the Fuji volcano, the 1783 (Tenmei) eruption of the Asama volcano, and the so-called *Kanto Loam*, volcanic soil deposits containing many Holocene to Pleistocene fall-out tephras, suggest the potential hazards from such volcanic activities. The small to moderate eruptions (VEI 1 to 2) that occurred at the Asama volcano resulted in minor ash falls in and around Tokyo a few times in every one to two decades. The Asama volcano will probably cause minor ash falls in the near future. Volcanic disasters from larger, but rarer, eruptions, rated VEI 4 to 5, are also considered, referring to the 1707 (Hoei) eruption of the Fuji volcano and the measures and predictions of the next Fuji eruption. This chapter notes not only disasters caused by ash falls but also those caused by lahars along the Tone, Edo, Sakawa, and Sagami Rivers connecting the Asama, Haruna, and Fuji volcanoes, as landform developments in these areas in the Holocene and historical disasters suggest that these drainage basins have the potential for lahar disasters. The impacts and frequencies of more severe eruptions, rated VEI 6 to 7, are considered by referring to geological records of air-fall tephras and/or pyroclastic flow deposits, such as the VEI 6 Hakone-Tokyo tephra (*ca.* 66 ka) and the VEI 7 Aira-Tn tephra (*ca.* 30 ka).

Keywords Volcanic disaster · Fall-out tephras · Tokyo · Fuji volcano · Asama volcano

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2.1 Introduction

No active volcanoes exist in the Tokyo metropolitan area (in this chapter, the Tokyo Metropolis and Saitama, Chiba, and Kanagawa Prefectures) excluding the islands off the main island of Japan (Honshu) and the west part of Kanagawa Prefecture (Fig. 2.1). Volcanic disasters causing severe damage have not occurred in this area during the last 200 years. This may have resulted in the area's residents becoming ignorant of volcanic disasters. However, according to historical documents, there is no doubt that this area has suffered from volcanic disasters in the past. As a representative example, the 1707 (Hoei) eruption of the Fuji volcano resulted in fall-out tephras (volcanic material) in Tokyo (Edo) in the Early Edo Period, and the 1783 (Tenmei) eruption of the Asama volcano caused a lahar (mudflow) that eventually

Fig. 2.1 Distributions of Quaternary volcanoes on the Japanese Islands and fall-out tephras covering the Tokyo metropolitan area during the last 100,000 years (Suzuki 2013). Distributions of the Aira-Tn (chain line) and Aso-4 (thick solid line) tephras are shown with isopach maps, and those of the Kikai–Akahoya, Kikai–Tozurahara, and Ontake-1st tephras (solid lines) with the limits of their distributions (From Machida and Arai (2003). Suzuki (2013))

reached the Tokyo Bay in the Late Edo Period (Fig. 2.2; e.g., Miyaji and Koyama 2007; Inoue 2009; Koyama 2009). Immediately after the Hoei eruption, the area along the Sakawa River in Kanagawa Prefecture was severely damaged by repeated lahar occurrences, due to thick fall-out tephras in its upper reaches. The so-called "Kanto Loam," a shallow and thick subsurface sediment covering the uplands in and around the Tokyo metropolitan area, is formed from alternations of multiple Holocene to Pleistocene fall-out tephras and volcanic soil deposits; it informs of the existence of countless falls of volcanic materials, not only in the last few hundred years but also in the last 1000–100,000 years.

Every year, we feel earthquakes in the Tokyo metropolitan area. In particular, after the 2011 Tohoku earthquake off the Pacific Coast, these earthquakes have occurred more frequently than before, partly in the form of aftershocks. In comparison, eruptions associated with fall-out tephras rarely occur in this area. The area's geographical condition, that is, the distances and directions from active volcanoes, suggests it is uncommon to suffer from volcanic disasters during one's lifetime.

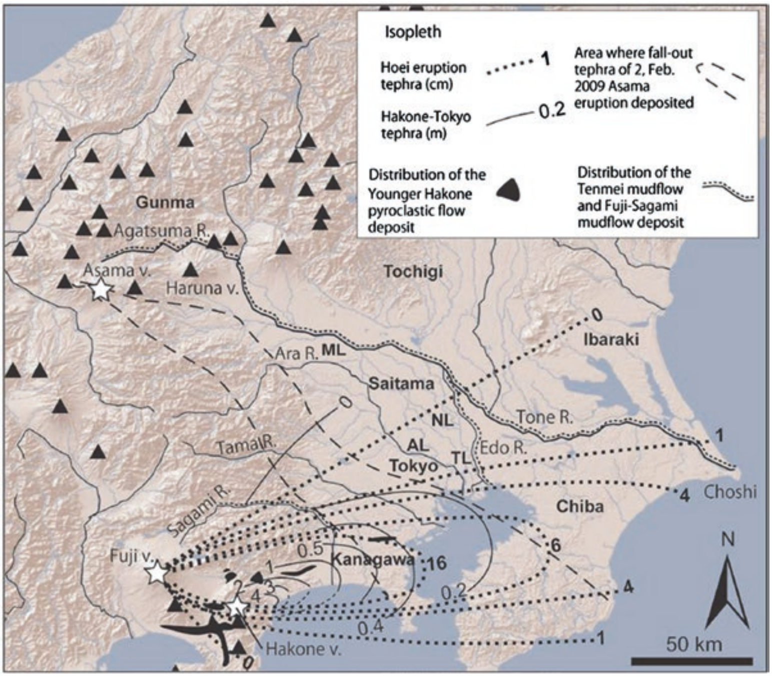

Fig. 2.2 Major historical volcanic disasters in the Tokyo metropolitan area (Suzuki 2013)
The area of ash fall from the 2009 (Feb. 2nd) eruption of the Asama volcano, isopach map of the Hoei eruption of the Fuji volcano, and isopach and distribution maps of the Hakone-Tokyo tephra (fall-out tephra and pyroclastic flow deposit) are from Maeno et al. (2010), Miyaji and Koyama (2007), and Machida (1977), respectively. The areas where the Tenmei and Fuji-Sagami lahars were recognized are from Inoue (2009) and City History Division of General Affairs Department, Sagamihara City (2009), respectively. *AL* Arakawa Lowland, *NL* Nakagawa Lowland, *ML* Menuma Lowland, *TL* Tokyo Lowland

Despite this, in recent years, much attention in the mass media has been focused on the next eruption of the Fuji volcano. However, we should focus not only on the next eruption of the Fuji volcano but also on the volcanic disasters that could result from other volcanoes.

Here, the phase and frequency of volcanic disasters, with reference to historical volcanic disasters in the area, are discussed to explore the likelihood of future volcanic disasters in the Tokyo metropolitan area.

2.2 Past and Future Volcanic Disasters

Volcanic disasters are generally complicated compared to earthquake disasters. Some of the phenomena resulting from an earthquake disaster, such as seismic motion, landslides, liquefaction, and tsunamis caused by rapid crustal movement, occur simultaneously. Phenomena resulting from volcanic disasters vary, including lava flows, pyroclastic flows, debris avalanches, fall-out, lahars, volcanic gases, and infrasound waves, indicating the existence of many methods of transporting volcanic materials on varying time scales. Each eruption is uniquely composed of some combination of these phenomena and conditions. Moreover, volcanic materials left by an eruption usually remain for a long period after the eruption, in areas both proximal and distal from the volcano. Thus, volcanic disasters are complex.

It is difficult to evaluate each volcanic disaster quantitatively due to the complexity of each type of eruption. The number of casualties or the economic losses may be one index to classify a disaster's intensity. Quantitative evaluation of an eruption is also difficult. However, in many cases, the volcanic explosivity index (VEI) (Fig. 2.3) (Newhall and Self 1982; Siebert et al. 2010), a relative measure of the explosiveness of volcanic eruptions, is often employed. Therefore, in this chapter, it is used as an indication of the relative size of the eruption.

The expected styles of volcanic disasters in the Tokyo metropolitan area are limited, and it is not difficult to describe their type, intensity, eruption VEI, and likelihood, nor to identify the candidate volcanoes for these disasters. Here we describe these disasters while referring to the record of past volcanic disasters, ranging from those resulting from minor and frequent eruptions to those resulting from severe and uncommon eruptions.

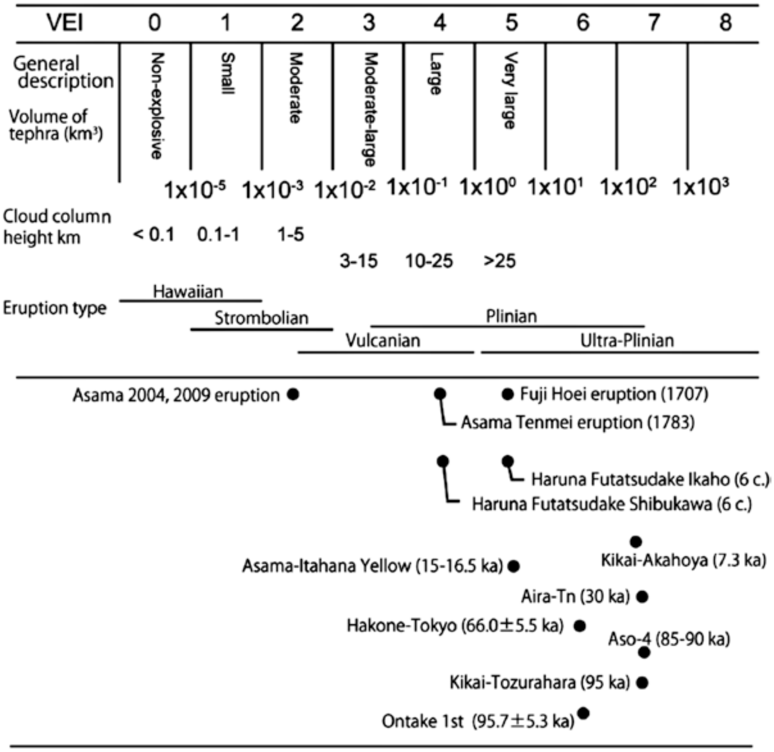

Fig. 2.3 Volcanic explosivity index (Suzuki 2013). Eruptive ages are from Machida and Arai (2003), Aoki et al. (2008), Hayakawa et al. (2009), and Smith et al. (2013). Representative eruptions are shown in the lower part of the figure

2.2.1 Tephra Falls Associated with Small to Moderate Eruptions of Nearby Volcanoes and Large Eruptions of Distant Volcanoes

It appears that the most frequent type of volcanic disaster in the Tokyo metropolitan area is caused by tephra falls. The last tephra fall originated from a small eruption of the Asama volcano, located 140 km northwest of Central Tokyo in May 2012. Minor ash falls were observed in an elongated area from West Gunma Prefecture to South Chiba Prefecture, including West Saitama and East Kanagawa Prefectures and the west Tokyo metropolis; the total amount of fall-out tephra was estimated to be 27,000–31,000 metric tonnes (Maeno et al. 2010) or 14,000–18,000 metric tonnes (Miyaji et al. 2010).

Similar or slightly larger eruptions of the Asama volcano, e.g., a vulcanian eruption in September 2004 causing ash falls in the Tokyo Metropolitan and South Tohoku areas and an eruption in 1983 resulting in ash falls in Tokyo Metropolis and Chiba Prefecture, are well known (Yoshimoto et al. 2005). Both eruptions, rated

VEI 2, resulted in some damage in the vicinity of the Asama volcano but no severe damage in Tokyo. In general, the frequency of VEI 2 eruptions is significantly higher than that of VEI 3 eruptions (Siebert et al. 2010). VEI 2 eruptions of the Asama volcano are not rare, as proven by its recent eruptive history, showing a few eruptions every one to two decades. We should, therefore, prepare for such an eruption of the Asama volcano and its associated ash fall.

Not only volcanoes located in the Kanto area (the Tokyo metropolitan area and Gunma and Tochigi Prefectures) but also distant volcanoes may result in tephra falls in the Tokyo metropolitan area following more intense eruptions. The 1914 (Taisho) eruption of the Sakurajima volcano (South Kyushu), 1000 km southwest of Tokyo, a Plinian eruption rated VEI 4, resulted in ash falls in the Kanto and Chubu (Central Japan) areas (Fukuyama and Ono 1981). According to a newspaper (Chohosha 1914) published on January 15, 1914, it was possible to write letters on outdoor laundry terraces covered with volcanic ash in Central Tokyo (Kudan, Chiyoda Ward). VEI 4 eruptions of volcanoes are not very frequent; however, there are some volcanoes in the region that could potentially erupt at the VEI 4 level, causing ash falls in the Tokyo metropolitan area. This indicates the necessity to focus attention on the multiple volcanoes located further than a few hundred kilometers from Tokyo (Fig. 2.1). It is also expected that huge VEI 7 eruptions, with extremely low frequency, at distant calderas will also cause ash falls; such cases will be discussed later.

2.2.2 VEI 4 and 5 Eruptions and Subsequent Lahars from Nearby Volcanoes: The Cases of the Fuji and Haruna Volcanoes

What will happen if VEI 4 or 5 eruptions occur at volcanoes near the Tokyo metropolitan area? This most likely depends on the type of eruption. The vicinity of the volcano will inevitably suffer severe damage. Because most of the Tokyo metropolitan area is far from volcanoes, the damage caused by ash falls, of which the highest risk is likely from the Fuji volcano, is the focus here.

2.2.2.1 Volcanic Disasters Caused by the Fuji Volcano

An eruption of the Fuji volcano is widely recognized as the most likely eruption to result in ash fall causing actual damage in the Tokyo metropolitan area. To prepare for a future volcanic disaster in this area emanating from the Fuji volcano, consideration of the effects of this volcano's 1707 (Hoei) eruption, rated VEI 5 and reported by abundant historical documents, is useful.

A general description of the 1707 (Hoei) eruption was reported by Miyaji and Koyama (2007) and Koyama (2009), and the detailed situation in Tokyo (Edo) was also introduced by Koyama et al. (2001), referring to the diary "*Ito Shimanokami Nikki*," which described not only the ash fall but also observations of the eruption column and the air shock.

How are local governments preparing for the next eruption of the Fuji volcano? The "Regional Disaster-prevention Plan for Volcanic Hazards by the Tokyo Metropolitan Government," published by the Tokyo Government's Disaster Prevention Council (2009), primarily considers disaster prevention for volcanic islands belonging to the Tokyo Metropolis. However, it does refer to expected damage and countermeasures against ash falls from the Fuji volcano according to the "Report of the Review Committee of Volcanic Hazard Mitigation," published by the Review Committee of Volcanic Hazard Mitigation (2004). This report mentions the influences of ash falls on health, structures, traffic, lifelines, agriculture, commerce, and sightseeing, under the assumption that a continuous eruption over 16 days and an ash fall with a total thickness of 2–10 cm occurs (Fig. 2.4). In addition, it points out that damage caused by flooding and lahars resulting from rainfall will occur, and provides guidelines for the Tokyo Metropolitan Government, local city offices, and disaster prevention organizations to promote measures against ash fall from the Fuji volcano.

In 2008, the Japan Meteorological Agency began operating a tephra fall forecast. For fairly large eruptions, this forecast provides a 6-h prediction of the area of tephra fall following an eruption, which is announced in the 30–40 min after the eruption. Figure 2.4 shows an example for the Fuji volcano (Tokyo Government's Disaster Prevention Council 2009). This enables us to prepare for a tephra fall in advance,

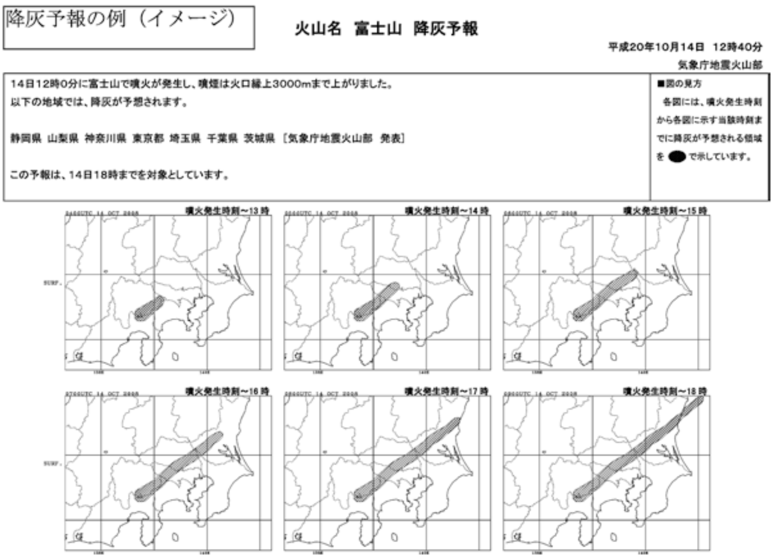

Fig. 2.4 Scenario for the future eruption of the Fuji volcano. Tephra fall as forecast by the Seismological and Volcanological Department, Japan Meteorological Agency (From Tokyo Government's Disaster Prevention Council (2009). (Suzuki 2013))

contrary to earthquakes, which may hit unexpectedly. Eruptions are generally accompanied by precursory phenomena, indicating the possibility of predictions (Ida 2008).

To prepare for an eruption of the Fuji volcano, we must pay attention not only to the tephra fall but also lahars, as suggested by the severe damage in Kanagawa Prefecture caused by the 1707 (Hoei) eruption. According to historical documents describing the post-eruption lahars, they concentrated in the area where tephra was deposited with a thickness greater than 10 cm (Review Committee of Volcanic Hazard Mitigation 2004). This was reflected in *The Volcanic Hazard Map of Mt. Fuji* published for ordinary citizens by the Mt. Fuji Volcano Disaster Management Conference (2004), illustrating the potential for lahars in the mountainous area of West Kanagawa Prefecture, the Miura Peninsula, and the Tama Hills (Hachioji to Machida, south Tokyo metropolis).

Despits its very low frequency, the edifice of the Fuji volcano has repeatedly suffered huge sector collapses, leaving large debris avalanche flow deposits and lahar deposits. A sector collapse occurred on the east slope of the Fuji volcano approximately 3 ka (ka = 1000 years ago), causing a huge lahar to flow down the Sakawa River into the Ashigara Plain, leaving deposits with a thickness of 40 m (Miyaji et al. 2004). Moreover, huge lahars flowed along the Sagami River approximately 22 ka, during the Last Glacial Culmination, forming the Fuji–Sagami Mudflow (Lahar) (Fig. 2.2: City History Division of General Affairs Department, Sagamihara City 2009). Currently, a large population and multiple structures exist in the areas these lahars reached. Geological records of these rare but larger lahars, useful for predicting severe damage, are not usually shown on hazard maps given to citizens, tending to leave them unaware of geological events. However, there is no reason to ignore lahar events at such scales, and they should be broadly publicized to citizens through various means.

2.2.2.2 Volcanic Disasters from Lahars Derived from the Asama and Haruna Volcanoes

Debris avalanches and lahars flow downwards, their paths depending on the surrounding landforms. Consequently, their distributions are usually controlled by river drainage basins. Therefore, lahar alarms are needed in the drainage basins accompanying a volcano when it erupts. Volcano exists in several drainage basins of the Tokyo metropolitan area. Two active volcanoes of Fuji and Hakone are located in the drainage basin of the Sakawa River, and Fuji located in the drainage basins of the Sakawa and Sagami Rivers. The Asama, Kusatsu-shirane, Haruna, and Akagi are located in the upper reaches of the Tone River. Next, the case of the Tone River will be discussed.

The Tone River, with the widest drainage basin in the Japanese Islands, flows from the mountainous area in Gunma Prefecture to the Kanto Plain (the largest plain in Japan), and eventually into the Pacific Ocean at Choshi, northeast of Chiba Prefecture (Fig. 2.2), and into the Tokyo Bay by dividing its course at the central part of the Kanto Plain. The lower reaches of its course were artificially constructed in the Early Edo Period. From the Early Jomon Period (7000–5500 years ago) until the early eighth century CE, prior to this construction, the Tone River flowed into the Ara River lowland and then into the Tokyo Bay (Kikuchi 1981; Kogure 2011; Kubo 2012). Since then, until the large construction called the "Work for the eastward shift of Tone River" (*Tonegawa-tosen-jigyo*), the Tone River flowed into the Nakagawa and Tokyo Lowlands and then into the Tokyo Bay. Its present course, featuring a confluence with the Kinu River and flowing into the sea at Choshi, was fixed after the 1600s (Okuma 1981a, b). This geomorphic development strongly suggests the possibility of a lahar disaster in the lowlands of the Tokyo Metropolis and Saitama Prefecture, such as in the Arakawa, Nakagawa, and Tokyo Lowlands.

As an example, the 1783 (Tenmei) eruption of the Asama volcano (rated VEI 4) is shown below. This eruptive event comprised vulcanian and Plinian eruptions associated with pumice falls, pyroclastic flows, debris avalanche flows, lahars, and lava flows, resulting in a tephra fall in the Kanto and Tohoku regions (Tsukui 2011). Inoue (2009) defined the pyroclastic flow and debris avalanche flow as the Kanbara debris flow and the lahar as the Tenmei mudflow, describing detailedly the damage caused by the lahar in the lower reaches.

The Tenmei mudflow flowed through the Agatsuma River, one of the upper reaches of the Tone River, and reached the mouths of the Tone River at Choshi and the Edo River at Tokyo (Edo) (Fig. 2.2). The Tenmei mudflow evolved from the Kanbara debris flow, which occurred at 10:00 AM, August 5, at the Asama volcano, and passed Satte, northeast of Saitama Prefecture (160 km from the summit of the Asama volcano) and located near the confluence of the Tone and Edo Rivers, from the night of that same day until noon of the next day. The contemporaneous documents describe pieces of houses, timber, human bodies, and horses flowing with the black muddy water filling the riverbed. Approximately 28 h later, the mudflow passed Kanamachi, Katsushika Ward, Tokyo, through the Edo River, containing parts of dead humans and horses. The 1783 (Tenmei) eruption had impacts not only immediately after the eruption but also in the long term. The lahar caused aggradation of the riverbed of the Tone River, resulting in frequent flood damage along the Tone River and in the lowlands of Tokyo (Okuma 1981a, b).

As shown above, the influence of the Asama volcano's 1783 (Tenmei) eruption was clearly described by several historical documents. However, it is necessary to also focus attention on future eruptions of the Haruna volcano located closer to Tokyo. The Haruna volcano erupted twice during the Kofun Period (250–538 AD). A former eruptive event, called the Haruna–Futatsudake–Shibukawa eruption (HFS) was rated VEI 4, and the later Haruna–Futatsudake–Ikaho eruption (HFI) was rated VEI 5 (Fig. 2.3) (Machida and Arai 2003); both provided abundant pyroclastic falls and pyroclastic flow deposits. Volcanic disasters caused by these two eruptions around the volcano in Gunma Prefecture have been archaeologically studied in detail (e.g., Noto 1989; Soda 1989). Ash fall deposits associated with HFI were detected in Kawaguchi, south of Saitama Prefecture (Tsuji 1989), suggesting a broad distribution from Gunma Prefecture to Saitama Prefecture. However, the influences of the eruption on the lower reaches of the Tone River, especially in the

Arakawa, Nakagawa, and Tokyo Lowlands, have not been explained in detail. Kogure (2011) suggested the existence of pumice originating from these eruptions in the Menuma Lowland, where the former Tone River course entered the Arakawa Lowland. Comparing the intensities of the two Haruna eruptions and the 1783 (Tenmei) eruption of the Asama volcano, and considering the distances to these volcanoes, the risk of volcanic disasters arising from a Haruna eruption is likely to be more severe than that from an Asama eruption. As Kubo (2012) pointed out, an evaluation of the influences of Asama and Haruna eruptions on the river basin is needed. We should consider the Haruna to be one of the active volcanoes that could cause a volcanic disaster in the Tokyo metropolitan area.

2.2.3 Huge Eruptions Larger Than VEI 6

We will now discuss rare but huge eruptions, larger than VEI 6. The VEI is often determined by the volume of the products, such as the fall-out tephras, pyroclastic flow deposits, and lava: VEI 6 for 10–100 km^3 and VEI 7 for 100–1000 km^3 (Fig. 2.3). Eruptions on such scales have not occurred during the last 2000 years in the Japanese Islands. Referring to the "*Atlas of Tephra in and around Japan*" (Machida and Arai 2003), eruptions of VEI 6–7 that produced fall-out tephras in the Tokyo metropolitan area during the last 100,000 years are as follows: the Hakone–Tokyo tephra eruption (Hakone volcano, 66 ka) and the Ontake 1st tephra eruption, both rated VEI 6, and the Kikai–Akahoya tephra eruption (Kikai caldera, 7.3 ka), the Aira–Tn tephra eruption (Aira caldera, 30 ka), and the Aso-4 tephra eruption (Aso caldera, 89 ka), all rated VEI 7. This indicates an average of one VEI 6–7 eruption every 10–20 thousand years.

2.2.3.1 The VEI 6 Eruption That Produced the Hakone–Tokyo Tephra at the Hakone Volcano

When considering volcanic disaster measures, it is impossible to ignore the eruption that produced the Hakone–Tokyo tephra at the Hakone volcano, approximately 66 ka. It is well known that the thicknesses of the pumice fall deposits of 20 cm in Tokyo, more than 30 cm in Kanagawa Prefecture, and a few meters in proximal areas resulted from a Plinian eruption (Fig. 2.2). In addition, this eruption was accompanied by a pyroclastic flow that produced the Younger Hakone pyroclastic flow deposit, which is distributed radially around the Hakone volcano, reaching West Yokohama and the Sagamino Upland in east Kanagawa Prefecture (Machida 1977; City History Division of General Affairs Department, Sagamihara City 2009). It is likely that the plants, animals, and ecosystems were instantly destroyed in the eruption. This eruption was likely one of the most catastrophic events to affect the Tokyo metropolitan area. Considering the huge present population and the political and economic functions of the city, if the same type of eruption occurred at the

Hakone volcano today, it would be one of the worst volcanic disasters in human history. However, the established history of the Hakone volcano during the last 500,000 years suggests that the Hakone–Tokyo tephra eruption was the final eruption of such intensity, and its subsequent history has been dominated by minor eruptions influencing its proximal area, such as the inner caldera. The *Volcanic Hazard Mitigation Map of Hakone-town,* published by the Disaster Prevention Division of the General Affairs Department in Hakone-town (2004), primarily expects damage to occur in and be limited to the caldera.

2.2.3.2 VEI 7 Eruptions Occurring at Calderas in Kyushu

Extremely large caldera-forming eruptions rated VEI 7 are qualitatively described as colossal and are a very-low-frequency phenomena on Earth, occurring only several times in the entire area of the Japanese Islands during the last 100,000 years. In addition, these intense eruptions occur at limited volcanoes, such as the huge calderas located on the Kyushu and Hokkaido Islands in Japan. Consequently, it suggests that no impact occur on the Tokyo metropolitan area caused by these calderas. Regarding the Aso-tephra eruption (89 ka, the largest eruption in the Japanese Islands) and the Aira–Tanzawa tephra eruption (30 ka), geological records indicate that only volcanic ashes composed of mostly fine volcanic glass shards fell and were deposited in Central Japan, including Tokyo, with a thickness of 10–20 cm (they were originally thicker prior to the compaction of the sediments). In case of a similar future eruption, damage from ash fall is likely to occur in the Tokyo metropolitan area. However, sudden fatal volcanic disasters caused by, for example, rapid pyroclastic flows, as in the case of an eruption of the Fuji volcano, are unlikely. Nonetheless, fall-out tephra associated with an extremely large VEI 7 eruption would cover the entirety of the Japanese Islands; consequently, health, construction, nuclear facilities, transportation, lifelines, agriculture, commerce, and industry would be damaged on a nationwide scale, resulting in a national crisis. In particular, the proximal area around the caldera would be entirely destroyed by pyroclastic flows. Many cases of such large eruptions are known worldwide, and their influences on plants, animals, ecosystems, and human beings in prehistoric times have been scientifically evaluated from the viewpoints of paleoenvironmental and archaeological studies (Machida 2002; Williams 2012). The evaluation of the influence of the Kikai–Akahoya tephra eruption (rated VEI 7) on South Kyushu in the Early Jomon Period has been controversial whether the ceramic culture was continuous or discontinuous (e.g., Shinto 2001; Kuwahata 2002). Concerning vegetation, the time required for the lucidophyllous forests to recover after the eruption was estimated to have been 100–300 years (Matsushita 2002); however, they are thought to have started growing approximately 600–900 years after the eruption (Sugiyama 2002). Further considerations of the influence of VEI 7 eruptions on the ecosystem, including human beings, are necessary.

Recently, the influences of and measures against these eruptions on human society have been discussed. Takahashi (2008) named these eruptions (VEI $\geq$ 7) super eruptions and considered where and how they will occur. It is likely that we will stop contemplating countermeasures because there is no way to avoid disasters, due to the enormous intensity of such an eruption, and their likelihood is extremely low. Indeed, Takahashi (2008) noted that measures against super eruptions are beyond the boundaries of the human intellect; however, he emphasized the significance of preparing for the worst and trying to get out of the difficulties.

We should recognize the possibility of super eruptions (VEI 7 eruptions), even though their frequency is very low, and we should know what to expect in both the proximal area around the volcano and distal areas, such as the Tokyo metropolitan area. Currently, there are no effective measures against a super eruption, leading to the conclusion that we should abandon hope of resistance. However, this does not mean we should cease seeking to understand super eruptions and to predict their influences on us. It is no longer permissible to ignore geological events with possibilities of once in every 1000–10,000 years, previously thought to be of interest only to the geosciences; this indicates the necessity to recognize these phenomena as a factor in human society. The Japanese communities that experienced the 2011 Tohoku earthquake off the Pacific Coast likely understand this, as the earthquake was recognized as a geological event occurring once every 1000 years. Human society should maintain an optimistic view that deeper understanding of these phenomena may lead to breakthroughs.

2.3 Conclusions

To anticipate future volcanic disasters of the types that will occur in the Tokyo metropolitan area, the phase and frequency of these disasters, referring to the history of past volcanic disasters in the area, were discussed. It is frequently said that the "*past is the key to the future*"; therefore, the mitigation of volcanic disasters in certain areas requires understanding the history of such disasters in those areas.

Fortunately, a sufficient number of historical documents related to volcanic disasters in the Tokyo metropolitan area have been collected; moreover, eruptive events in prehistoric times have also been revealed in detail. An accumulation of data on past volcanic disasters and eruptive events can improve our preparation for future eruptions. According to statistical analysis of the collected data, the types of possible volcanic disasters must be predicted spatially from the standpoint of probability theory. An attempt was made by Suto et al. (2007) to collect, digitize, and catalogue data of fall-out tephras described in the literature. This dataset can extract the attributions of tephras (e.g., the name, age, and thickness) for every 1-km region in the Japanese Islands, and it is possible to access data of the number of incidents and the accumulated thicknesses of fall-out tephras at certain points during certain periods. For example, this database indicates that the number of incidents and the accumulated thicknesses of fall-out tephras at the Tokyo Metropolitan Government Building in Central Tokyo during the last 1000, 10,000, and 100,000 years number three times and approximately 8.6 cm, five and approximately 19 cm, and 17 and approximately 810 cm, respectively.

Because Suto et al. (2007) closed isopleths if they were unclosed in previous studies and/or added isopleths, the number of incidents and the accumulated thicknesses of fall-out tephras increased; however, it is an adequate and effective database for the prediction of volcanic disasters. Moreover, this database can provide the probabilities of a tephra fall and could play a significant role in volcanic disaster measures spanning long periods. Promotion of the establishment of a statistical database on tephra and each volcano's eruptive history, along with the construction of scenarios for future eruptions, contributes to effective preparation against volcanic disasters.

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Chapter 3
Climate Variations in Tokyo Since the Edo Period

Masumi Zaiki and Takehiko Mikami

Abstract This chapter discusses climate variations in Tokyo, based on the reconstructed summer temperatures since the eighteenth century and instrumental meteorological data from the nineteenth century to the present. During the Little Ice Age, especially in the eighteenth century, remarkable cool episodes occurred in the 1730s, the 1780s, and the 1830s. These cool conditions could be a significant reason for the severe famines that occurred during the Edo period. Around the 1840s and 1850s, near the end of the Edo period, it was rather warm, which could correspond to the end of the Little Ice Age in Japan. Although there was a low-temperature period in the 1900s, a long-term warming trend could be seen, especially in winter temperatures and daily minimum temperatures, throughout the twentieth century. While annual precipitation has been increasing during the last 30 years, relative humidity has been decreasing since the late nineteenth century. This could be the result of saturated vapor pressure rise due to warming and a loss of water bodies due to urbanization. During the last century, both warmer and wetter conditions in summer and autumn, and drier conditions in winter and spring, were documented by analyzing hythergraphs.

Keywords Temperature · Precipitation · Relative humidity · Hythergraph · Historical weather record · Instrumental meteorological record

3.1 Introduction

Tokyo has grown at a remarkable rate, even by global standards, starting with a rapid increase in population in the Edo period (1603–1868), and followed by the concentration of people and industry since the Second World War. According to the Japan Population Census, Tokyo's population was 860,000 in 1872, 3.5 million in

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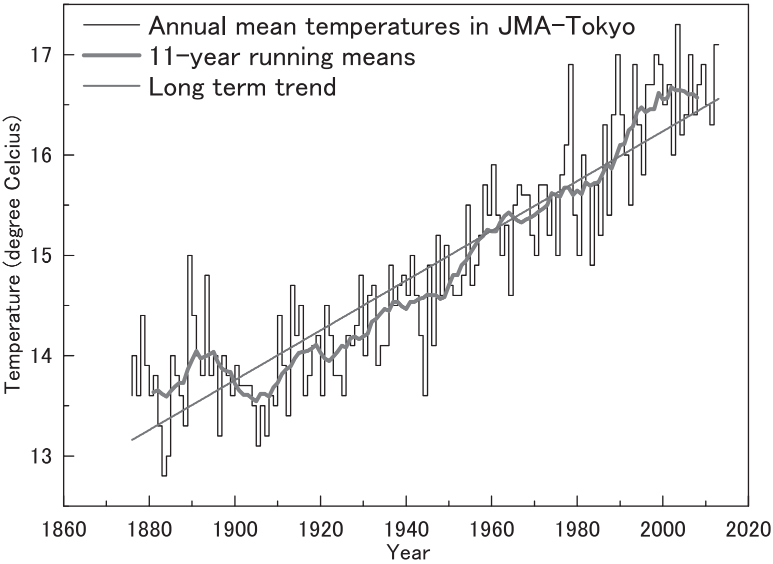

Fig. 3.1 Annual mean temperatures as recorded by JMA-Tokyo for 1876–2013 (Modified from Zaiki and Mikami 2013)

1945, and 13.3 million in 2015. While the global mean temperature rose by 0.71 °C per century (over the statistic period 1891–2015) (Intergovernmental Panel on Climate Change 2013; Japan Meteorological Agency 2016), the annual mean temperature in Tokyo has been rising at a rate of 3.2 °C per century (over the statistic period 1931–2015), influenced by global warming and the urban heat island effect (Japan Meteorological Agency 2016). This trend is obvious in the temperature variations for Tokyo measured by the Japan Meteorological Agency (JMA) since 1876 (Fig. 3.1). Before official meteorological measurements by the JMA began in the 1870s, the Edo period had experienced the worldwide cooling commonly known as the Little Ice Age (Matsumoto 1992; Mikami 1992; Lamb 1995). Numerous volcanic eruptions in the period may also have had some influences. The cold climate of the times is thought to have played a role in frequent severe famines. However, instrumental meteorological measurements for Edo period Japan are only available from the late Edo period, from the 1820s onward, and were only recorded at a few locations, such as Tokyo and Nagasaki (Können et al. 2003; Zaiki et al. 2006). Accordingly, weather descriptions in historical documents have been used to reconstruct the climate in the Edo period (Maejima and Tagami 1983).

In Sect. 3.2, we describe what kinds of climate data can be used to learn about Tokyo's climate, particularly before the JMA was founded. In Sect. 3.3, we discuss the characteristics of climate variations in post-Edo Tokyo that can be understood from the different kinds of climate data, mainly in relation to temperature, precipitation, and humidity. We focus on variations in July (summer) temperatures in the Edo period, from which only limited climate data are available. We examine the characteristics of cooling trends in the Little Ice Age, the end of the Little Ice Age, and the subsequent period of warming. From climate data including temperature, precipitation, and humidity, we then offer an overview of long-term trends in the period since the JMA was founded.

3.2 Data for Learning About Tokyo's Climate

3.2.1 Temperatures Reconstructed from Weather Records in Old Diaries

Systematic weather observations using instruments in Tokyo began in 1825, in the late Edo period (Zaiki et al. 2006). To learn about the climate before then, surrogate data must be used to infer the weather conditions of the times. Mikami (1996) focused on a negative correlation between precipitation frequency and monthly mean temperatures in Tokyo in July (summer). Using continuous weather records from the 1700s written in the diaries of the Ishikawa family (Ishikawa Nikki), who lived in Hachioji (Fig. 3.2a), a western suburb of Tokyo (Hachioji Historical Museum 1991), Mikami (1996) reconstructed July (summer) temperatures for Tokyo from 1721 to 1940. The temperatures reconstructed from this data include estimation errors. We use these reconstructed July (summer) temperature values

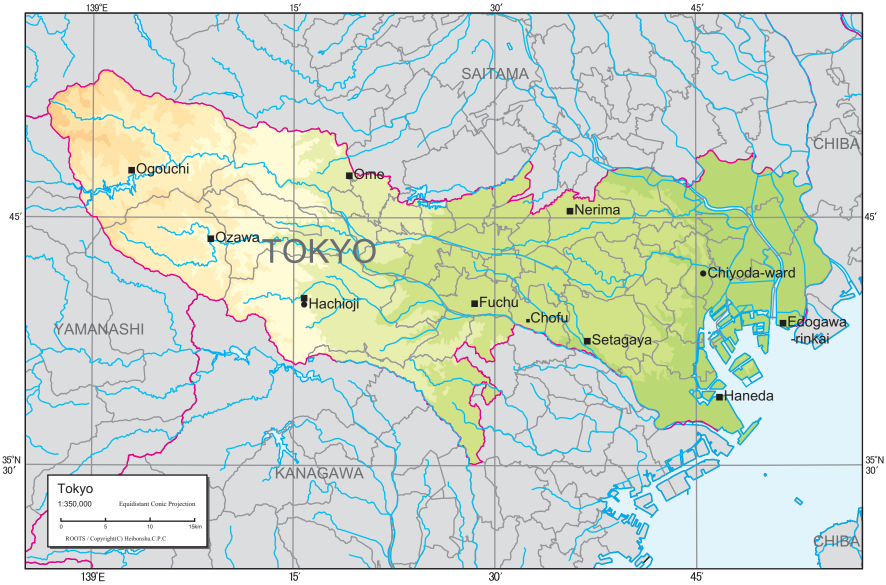

Fig. 3.2a Map of Tokyo. The measurement sites of AMeDAS in Tokyo are indicated with black squares

when discussing the characteristics of long-term variations in temperature covering the eighteenth century, in which measurements with meteorological instruments were not being conducted in Tokyo.

3.2.2 Instrumental Meteorological Records Before the Founding of the JMA

According to the JMA (1975) and Zaiki et al. (2006), systematic weather observations were conducted in Tokyo even before the JMA's founding in 1875. From 1825 to 1828, temperature and air pressure were measured three times per day by P.F. von Siebold at the Dutch mission at Nagasakiya Inn near Edo Castle (now the grounds of Tokyo Imperial Palace). These records have been preserved with temperature measurement records by von Siebold in Nagasaki City on the island of Kyushu (Fig. 3.3) and in "Sei'u-shoukou-hyou". From 1839 to 1855, temperature and pressure were measured three or four times per day by the Tenmonkata, the officer in charge of astronomy, in compiling the lunisolar calendar of the Tokugawa Shogunate (Amano 1953). These records were preserved in "Reiken-koubo" (Fig. 3.4). From 1872 to 1878, the German meteorologist E. Knipping took measurements including temperature, pressure, and relative humidity three times per day at Kaisei School (a precursor institution of the University of Tokyo) in the Kanda-Nishikichou neighborhood (Fig. 3.2b and 3.5). He reported his findings (Knipping 1873–1876) in the proceedings of the Deutsche Gesellschaft für Natur- und Völkerkunde Ostasiens (the German East Asian Society). Almost all meteorological observations in this period were conducted by foreign residents or Japanese scholars of Western science, who had the scientific knowledge and instruments required to conduct the measurements.

The numerical data from these measurements cannot be used in their raw form, because the units differ from those of modern meteorological data, there were significant differences between the altitudes of the measurement sites, and corrections to pressure (for temperature, altitude, and gravity) were not applied. Zaiki et al. (2006) corrected and standardized the nineteenth-century measurements of temperature and pressure to make the data consistent with modern measurements by the JMA. Quality control was applied to the corrected and standardized data to identify and remove values that were very extreme due to instrument malfunctions, instrument relocation, etc. The results have been made available to the general public (http://www.cru.uea.ac.uk/cru/data/japan/). Even though the data has been corrected and standardized, the meteorological measurements of the time inevitably had poor accuracy compared to modern instrumental meteorological data, for reasons such as low accuracy of the instruments and inconsistency of measurement conditions.

Fig. 3.2b Map of the Otemachi area of Chiyoda Ward, Tokyo. The numbered circles indicate the measurement sites of JMA-Tokyo. (1) Tameike-Aoichou (June 1875–June 1882); (2) Daikanchou (July 1882–December 1922); (3) Motoechou (January 1923–February 1964); (4) Otemachi (March 1964–November 2014); (5) Kitanomaru Park (December 2014–present). The base map was obtained from the Geospatial Information Authority of Japan

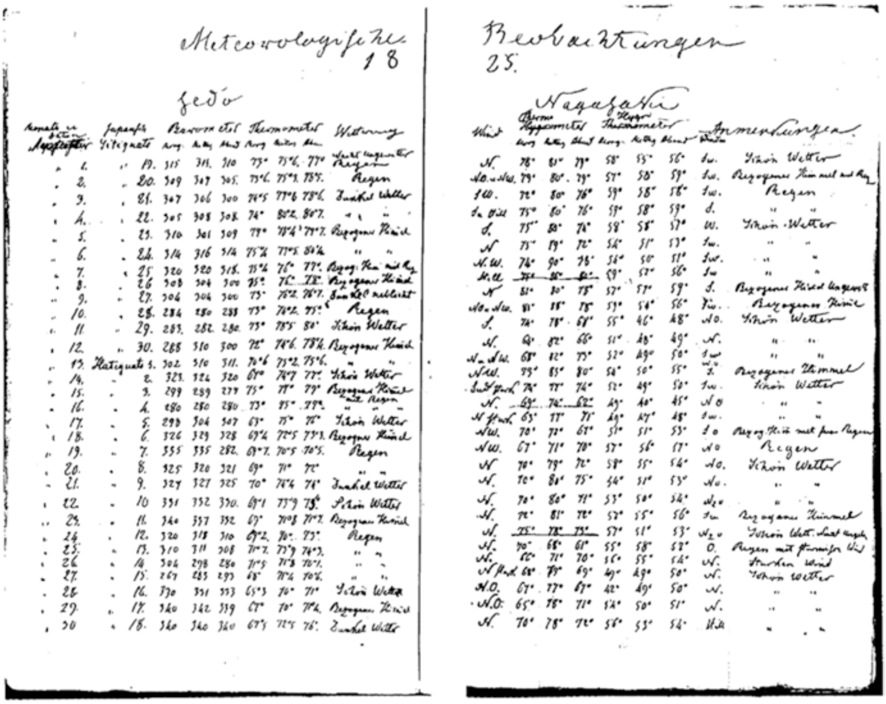

Fig. 3.3 The September 1825 meteorological records in Edo (Tokyo) and Nagasaki, chronicled by P.F. von Siebold. The left side refers to the observations in Tokyo, indicated as "Jedo" (stored in Nagasaki Prefectural Nagasaki Library, Japan and the Library of Ruhr University, Bochum, Germany) (Zaiki and Mikami 2013)

3.2.3 Meteorological Data from the JMA

The first instrumental meteorological observation by the precursor to the JMA was conducted at the weather station called Hakodate Climate Observatory in Hakodate, Hokkaido in August 1872 (from 1942, it was called the Hakodate Marine Meteorological Observatory, and from 2013, the Hakodate Local Meteorological Office); in Tokyo, the JMA started operations (within the Geographical Bureau of the Home Ministry in the Tameike-Aoichou neighborhood, Fig. 3.2b in June 1875 (JMA 1975). At the time, measurements of temperature, pressure, relative humidity, precipitation, etc. were taken three times per day. As time passed, the frequencies of measurement and the number of meteorological elements being measured increased. The JMA was originally called the Tokyo Meteorological Observatory; it changed its name to the Central Meteorological Observatory in January 1887, and then to the Japan Meteorological Agency in July 1956.

Meteorological observation in Tokyo by the JMA (JMA-Tokyo) has been relocated to several places since its the foundation in the Otemachi area of Chiyoda ward (Fig. 3.2b). In December 2014, measurement was transferred to a weather

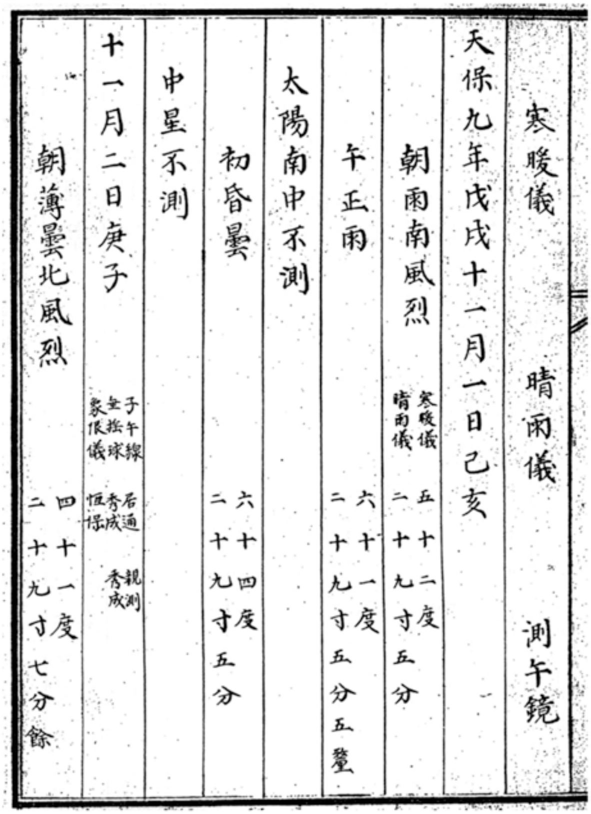
寒暖儀 晴雨儀 測午鏡
天保九年戊戌十一月一日己亥
朝雨南風烈 寒暖儀 晴雨儀 五十二度 二十九寸五分
午正雨 六十一度 二十九寸五分五釐
太陽南中不測
初昏曇 六十四度 二十九寸五分
中星不測
十一月二日庚子 子午線 垂揺球 象限儀 居通 季成 恒保 観測 季成
朝薄曇北風烈 四十一度 二十九寸七分餘

Fig. 3.4 The December 17 and 18, 1838 meteorological records in "Reiken-koubo" (stored in the National Archives of Japan) (Zaiki and Mikami 2013)

station in Kitanomaru Park, located 900 m west of the previous site in Otemachi. Due to this location change, the JMA claimed that inhomogeneity exists in its temperature and relative humidity data.

In addition to JMA-Tokyo, there are several measurement sites in Tokyo of the Automated Meteorological Data Acquisition System (AMeDAS) network (Nerima, Setagaya, Edogawa-rinkai, Haneda, Chofu, Fuchu, Hachioji, Ome, Ozawa, and Ogouchi) (Fig. 3.2a). Of these, Setagaya, Chofu, and Ozawa only measure precipitation.

For this chapter, we used data on temperature, precipitation, and relative humidity from JMA-Tokyo since 1876. All these data can be accessed through the JMA's website (http://www.data.jma.go.jp/obd/stats/etrn/index.php).

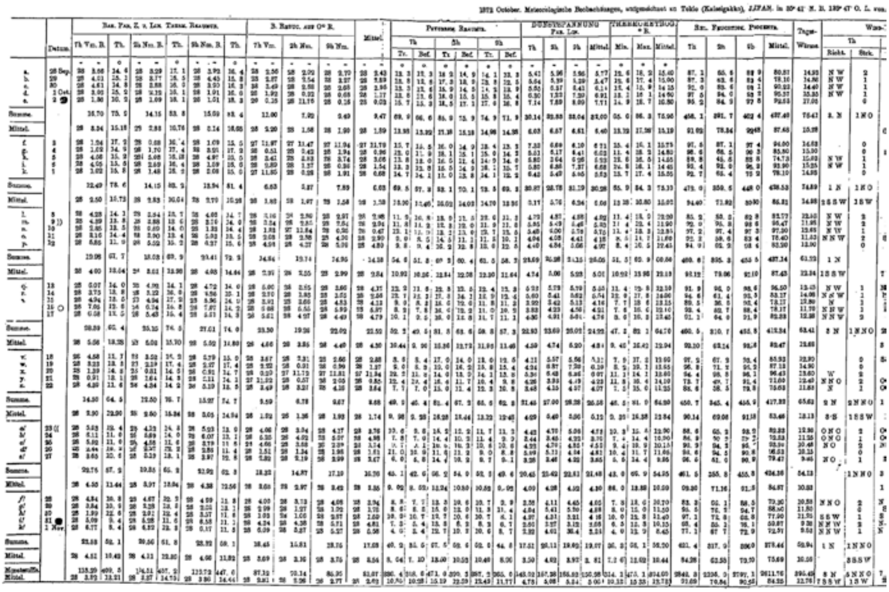

Fig. 3.5 The October 1872 meteorological records in Tokyo, chronicled by E. Knipping (stored in the library of Deutsche Gesellschaft für Natur- und Völkerkunde Ostasiens, Tokyo, Japan) (Zaiki and Mikami 2013)

3.3 Climate Variations in Tokyo

3.3.1 Long-Term Temperature Variations Since the Eighteenth Century

The Edo period coincided with the time known as the Little Ice Age, a worldwide cooling that ran from the fourteenth century to the mid-nineteenth century (Lamb 1995). (The Edo period was the time of the Tokugawa shogunate; the end of the shogunate was the end of the Edo period.) The July mean temperatures in the eighteenth and nineteenth centuries (1721–1900), as reconstructed from climate records in the aforementioned diaries (Mikami 1996), were approximately 1–2 °C colder than July means from JMA-Tokyo for 1981–2010 (averaging 25.8 °C; see Fig. 3.6). In particular, the July mean temperature over the eighteenth century (1721–1800) was 23.7 ° C, a remarkable low-temperature trend. In the eighteenth and nineteenth centuries, the three great Edo-period famines (the Kyouho Famine, the Tenmei Famine, and the Tenpo Famine) were caused by successive poor harvests due to bad weather in the 1730s, the 1780s, and the 1830s, respectively, coinciding with low-temperature peaks. Historical documents from the 1780s also describe the Ryogoku River and the Asakusa River freezing over (Imai 2003). These cold conditions were not limited to Edo; similar trends were seen in the rice-growing area of the Tohoku region (Northeast Japan). In those days, Edo was dependent on rice transported

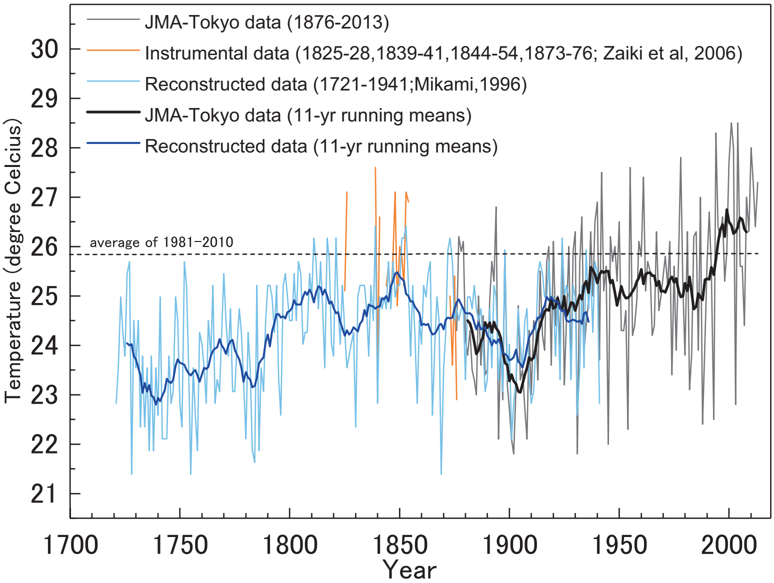

Fig. 3.6 July temperatures in Tokyo since the eighteenth century. Modified from Zaiki and Mikami (2013)

from the Tohoku region. As food shortages worsened, the prices of foods other than rice also rose. The effects of food shortages and rapidly rising rice prices in Edo are thought to have rippled out to other regions, causing food scarcity in the regions and flows of refugees to Edo; thus, the famines had severe effects nationwide.

The cold eased somewhat in the nineteenth century, with a July mean temperature from 1801 to 1900 of 24.7 °C. From the reconstructed temperature measurement data in Figs. 3.6 and 3.7, it can be seen that there were higher temperatures, comparable to those of the present-day, in the 1840s and 1850s, near the end of the shogunate period. This warm period coincides with similar trends in winter temperatures reconstructed from the weather records in old diaries from Kawanishi, Yamagata Prefecture, northeast Japan (Hirano et al. 2012), and the temperatures measured by the Otaka family in the 1850s and 1860s in Mito, Ibaraki Prefecture, northeast of Tokyo (Zaiki et al. 2009). However, the trend in this period was not consistent warming: periods with large year-to-year variations can be identified. Opinions are divided in different parts of the world on when the Little Ice Age actually started and ended (Matsumoto 1992). In Japan, however, the Little Ice Age seems to have ended with this warm period at the end of the shogunate.

From the beginning of the Meiji period to the 1900s, there was then a period of temporary cooling (Figs. 3.6 and 3.7). The summer (July) temperature variations (Fig. 3.6) and the summer (June, July, and August) temperature variations (Fig. 3.7) show cooling until the 1900s. From variations in other seasons and annual mean temperatures, a persistent low-temperature trend, around 2 °C below modern values (1981–2010) can be seen. Consequently, cold weather damage was frequent,

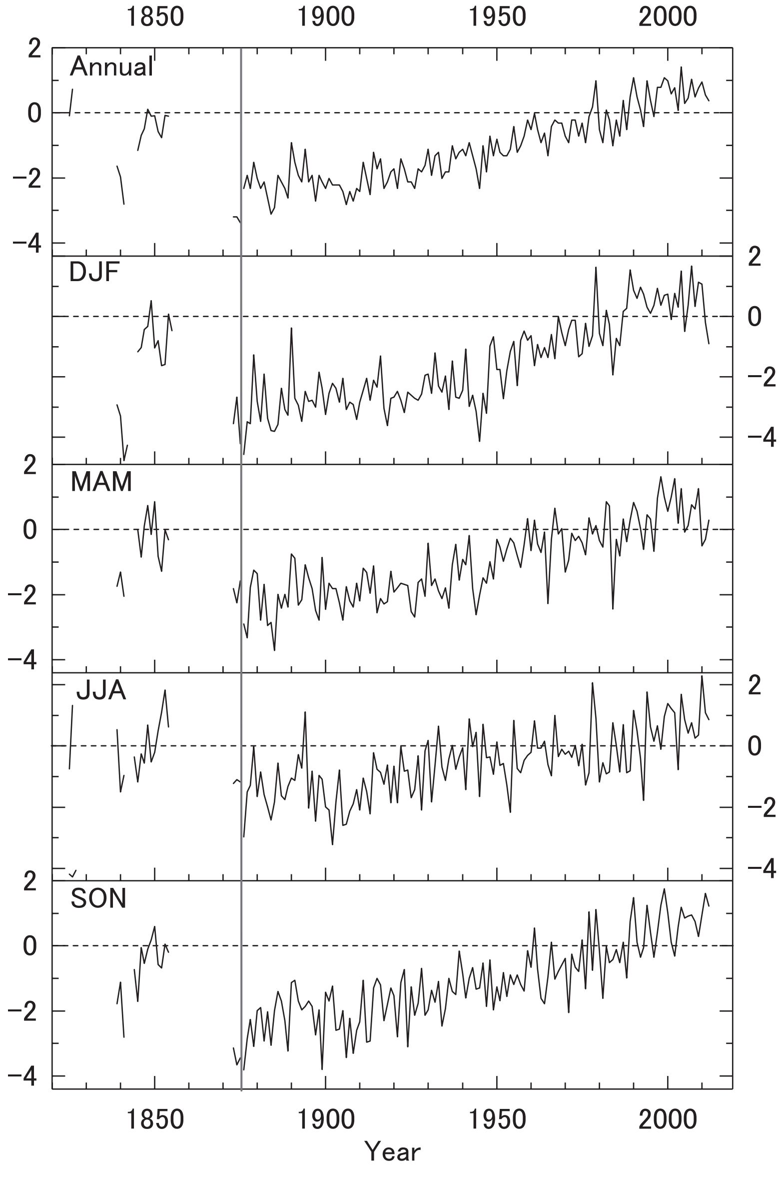

Fig. 3.7 Annual and seasonal temperatures (°C) in Tokyo for the period 1825–2013, relative to the mean of 1981–2010 (Zaiki and Mikami 2013). The gray thick vertical line indicates the year of JMA-Tokyo's foundation (1875)

particularly in the Tohoku region. The years in which the cold caused particularly great damage, 1902, 1905, and 1913, are referred to as the three great cold weather damage years of the Meiji and subsequent periods.

The climate then warmed until the 1940s. Mean temperatures rose by approximately 2 °C over the 40 years from 1910; this trend featured particularly striking summer and autumn temperature variations (Fig. 3.7). From the 1950s to the 1970s, changes were slight. Temperature variations in the 1970s then showed a brief cooling trend. From the 1980s to the present day, the influence of global warming has combined with the urban heat island effect characteristic of large cities, causing warming to progress rapidly at a pace of approximately 0.8 °C per decade. The mean temperatures recorded by JMA-Tokyo (from 1931 to 2015) have been rising at 3.2 °C per century. Distinguishing between the seasons, this rising trend has been particularly notable in winter (December, January, and February), at 4.3 °C per century (Japan Meteorological Agency 2016).

Mikami (1996) has conducted a periodicity analysis of the chronological temperature data, combining the July (summer) temperatures for 1721–1875 reconstructed from historical weather records with the July mean temperatures recorded by JMA-Tokyo for 1876–1995. The results identified periods influenced by solar activity (21 years and 10.5 years), the El Niño Southern Oscillation (6.3 years, 5.0 years, and 3.2 years), and the quasi-biennial oscillation (2.18 years).

3.3.2 Temperature Variations from the Twentieth Century

Regarding temperature variations as the urbanization of Tokyo advanced from the twentieth century to now, studies have been conducted to find the rates of temperature rises using JMA measurements for Tokyo and other major cities in Japan (Fukui 1968; Arakawa et al. 1970; etc.). Late at night in early March 1939, Fukui and Wada (1941) conducted mobile measurements of temperature using motor vehicles in what was then Tokyo City (generally corresponding to the present-day 23 wards), showing by isotherms that temperature differences between the central parts of the city (the inner city) and the suburbs reached 5 °C. This is a valuable example of a distinct urban heat island being observed in Tokyo before the Second World War. In the present day, through high-density observations in the Tokyo metropolitan region by our own research group, great progress has been made in clarifying the summer urban heat island effect centered on Tokyo and its causes (Mikami et al. 2011; Yamato et al. 2011; etc.). Our main purpose in this chapter is to discuss climate variations in Tokyo; therefore, see Mikami (2012) and Fujibe (2011, 2012) for discussion of the urban heat island associated with Tokyo's urbanization.

Figure 3.8 shows annual means for daily maximum temperatures, daily mean temperatures, and daily minimum temperatures for Tokyo. To make the long-term trends clearer, 11-year moving means are plotted (the thick lines). The most notable rising trend is in the daily minimum temperature, the rise in which is especially remarkable since the 1950s. Meanwhile, the annual mean value of the daily maximum temperatures

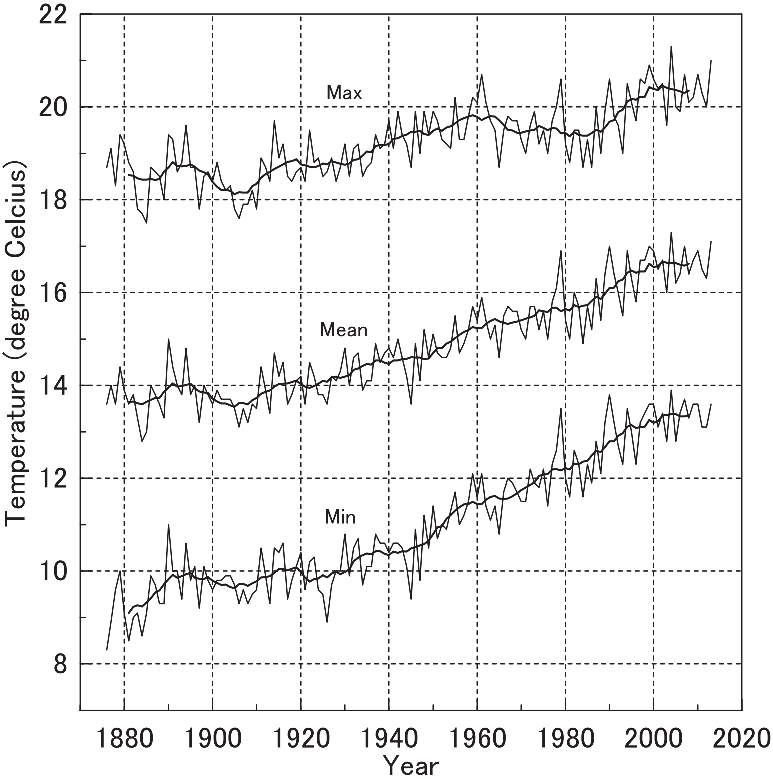

Fig. 3.8 Long term annual mean variations in the daily maximum, daily mean, and daily minimum temperatures as recorded by JMA-Tokyo for the period 1876–2013. The thick line indicates the 11-year running means (Modified from Zaiki and Mikami 2013)

rose from the 1920s to the 1960s, then fell gently until the 1980s, before returning to a rising trend since 1990. The temporary downward trend in the daily maximum temperatures from the 1960s to the 1980s was observed over large areas of the northern hemisphere; it may have been due to a weakening of solar radiation reaching the Earth's surface, attributable to an increase in atmospheric microparticulates caused by pollution in that period (Wild 2009).

3.3.3 Precipitation Variations from the Twentieth Century

We examined long-term trends for annual precipitation, a major climate element, together with temperature, over the period for which measurement data have been obtained in Tokyo (Fig. 3.9). In contrast to temperature, no significant trends of rise or fall could be identified; large year-on-year variations are characteristic of precipitation. The mean value of annual precipitation over the whole period was 1530 mm.

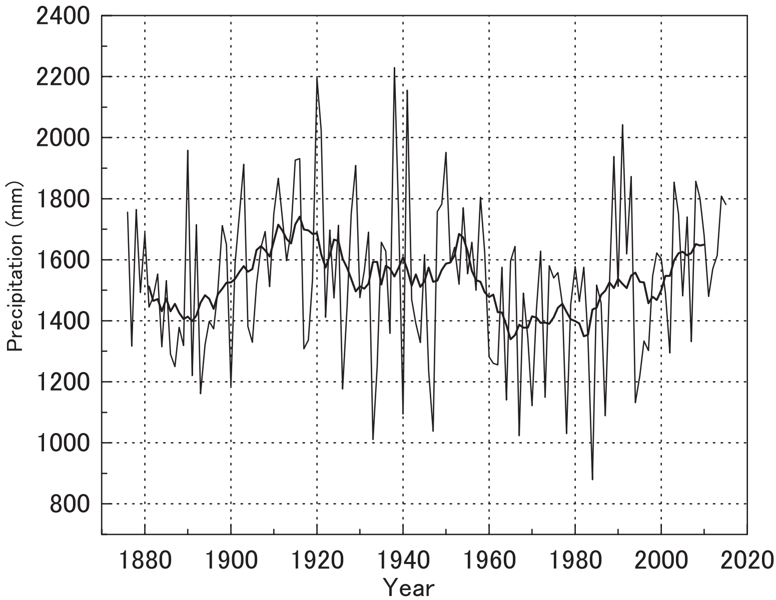

Fig. 3.9 Long term variations in annual precipitation in JMA-Tokyo for the period 1876–2015. The thick line indicates the 11-year running means (Modified from Zaiki and Mikami 2013)

The year with the highest precipitation (1938) had 2230 mm and the year with the lowest (1984) had 880 mm, the difference being a ratio exceeding 2.5. If decadal means are considered, the 1910s had relatively high precipitation (1712 mm) and the 1960s relatively little (1345 mm), a difference exceeding 350 mm. Over the long term, there was a declining trend from the beginning of the twentieth century to the 1980s, which switched to a rising trend from the end of the twentieth century into the twenty-first century. The mean precipitation in the first decade of the twenty-first century (2001–2010) was 1628 mm, a level close to the high-precipitation period at the beginning of the twentieth century.

3.3.4 Aridification of the City Shown by Humidity

As described above, there has been a rising trend in annual precipitation recently, but this does not necessarily imply increasing humidity. Rather, as expressed by "Tokyo desert," using terminology commonly applied to large cities such as Tokyo, the potential for aridification is high. We plotted long-term trends in relative humidity in Tokyo, distinguishing between annual means, January (winter) means, and July (summer) means (Fig. 3.10). Since the late nineteenth century, a declining trend in relative humidity can be clearly seen for both winter and summer. In particular, the relative humidity in January was close to 70% in the late nineteenth

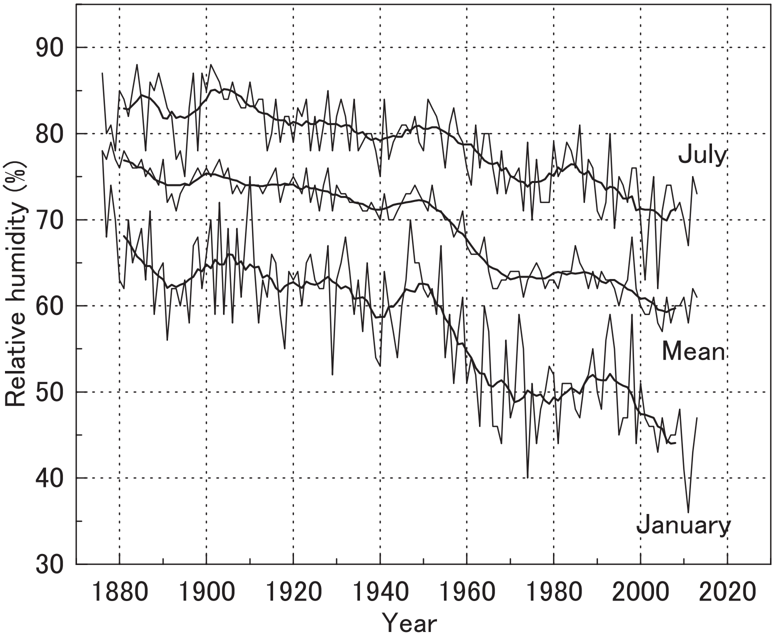

Fig. 3.10 Long term variations in relative humidity for January, July, and the annual means as recorded by JMA-Tokyo for the period 1876–2013 (Modified from Zaiki and Mikami 2013)

century but has fallen to 40–50% in recent years. This could be mainly due to saturation vapor pressure rising as the temperature rises.

To confirm the long-term trend of actual amounts of water vapor in the atmosphere, we calculated Tokyo's volumetric humidity (g/m^3) in July and January since 1876 (Fig. 3.11). Although both time series show long-term decreasing trends since the late nineteenth century, somewhat different trends could be found in the period since the 1970s. Summer (July) volumetric humidity appears to show increasing trends in this period. Omoto et al. (1994) and Fujibe (2002) also reported increasing trends of summer water vapor amounts in Osaka and Tokyo since the late twentieth century. However, vapor amounts have shown a long-term falling trend, which is probably because water bodies and areas of vegetation have decreased with the increase in the surface area covered by concrete and asphalt through urbanization.

3.3.5 Climatological Characteristics Based on Hythergraphs

Variation trends in the climate elements of temperature, precipitation, and humidity have been examined above. We now discuss climate variations in Tokyo based on hythergraphs combining annual variations in temperature and precipitation derived from the two climatological normals for 1881–1910 and 1981–2010. Hythergraphs

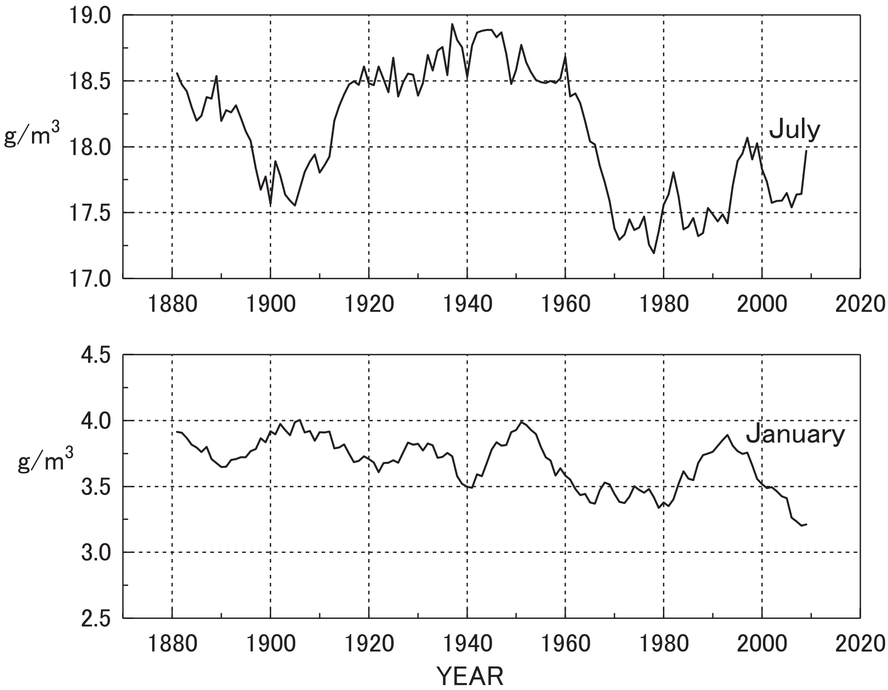

Fig. 3.11 Long term trends in volumetric humidity (g/m^3) in Tokyo in July (upper chart) and January (lower chart) since 1876. The lines indicate the 11-year running means

are useful for describing differences in the climates of different places from patterns of annual variations in temperature and precipitation. By showing different time periods for the same place, a hythergraph can also describe long-term climate changes. If there had been no climate change at all over the century, the two plots would match up; in reality, the two are greatly offset from one another (Fig. 3.12). Regarding climate variations in Tokyo, the feature that can be discerned from Fig. 3.12 is that the variation trends in temperature and precipitation have differed between the seasons.

Winter (December, January, and February) has the lowest values of both temperature and precipitation in a typical year, which are clearly seen to have shifted upward and a little to the left. Therefore, there has evidently been a significant rise in temperature and a slight fall in precipitation over the century. In contrast, summer (June, July, and August) exhibits a shift upward and to the right, demonstrating a rise in temperature accompanied by a rising trend in precipitation. Spring shows similar variation trends to winter, and autumn shows similar variation trends to summer. Therefore, over the past century in Tokyo, there has been a warming trend throughout the year, with summer and autumn becoming wetter, while winter and spring have become drier. However, as discussed above, year-on-year variations in

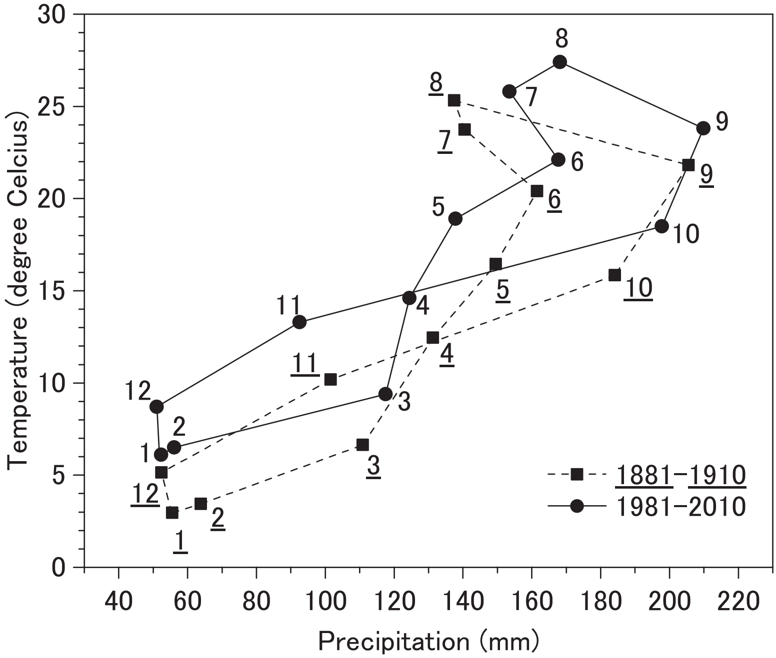

Fig. 3.12 Hythergraphs of JMA-Tokyo for 1881–1910 and 1981–2010 (Zaiki and Mikami 2013). Monthly mean values of temperature and precipitation in Tokyo are marked on the vertical and the horizontal axes, respectively. The solid line is plotted for the modern mean values (1981–2010) and the broken line is plotted for the mean values one hundred years prior (1881–1910). The numeral near each mark indicates a month, underline numerals marking the 1881–1910 values

temperature, precipitation, and humidity and medium- to long-term variations at the decade scale can also be clearly observed.

3.4 Conclusions

For the period prior to the JMA's founding, temperature data estimated from weather records in historical documents and instrumental meteorology data collected by the Edo shogunate and foreign residents are available. Although the observed climate elements are limited, climate data over a relatively long timescale are available for Japan. From these climate data, it can be seen that the very cold climate in the eighteenth century, coinciding with the Little Ice Age, hit several peaks and was persistent. In the mid-nineteenth century, the final years of the shogunate were a period in which the Little Ice Age came ended, temperatures temporarily rose, and there were large temperature variations. The beginning of the twentieth century was a cold period comparable to the low temperatures of the Little Ice Age, but was followed by a warming trend of long duration. The trend of rising temperatures in the twentieth century is strikingly apparent for winter temperatures and in trends for the daily minimum temperature. In the last 30 years, due to global temperature rises and city temperature rises caused by the urban heat island effect, warming has proceeded rapidly. However, a clear urban heat island had already been observed in Tokyo before the Second World War.

There were large year-to-year variations in precipitation in the twentieth century: it showed a declining trend from the beginning of the twentieth century to the 1980s, then switched to a rising trend from the 1980s into the twenty-first century. Meanwhile, relative humidity has shown a distinct declining trend since the end of the nineteenth century; this is probably due to saturation vapor pressure rising as the temperature rose and human construction covering increasing amounts of the surface. By comparing with the hythergraph for a hundred years ago, it can be seen that Tokyo's climate has changed significantly over the past century, with warming being accompanied by increasing humidity in summer and autumn and aridification in winter and spring.

Climates periodically undergo change cycles, and it is conceivable that Tokyo will return to cooling in the future. However, the recent warming trend caused by the effects of human activity in Tokyo is striking. Similarly to global temperature changes, it is expected that the temperature in Tokyo will continue to rise in the future. Given the damaging effects on agriculture and fisheries associated with warming-induced changes in the natural environment, we are likely entering a period in which economic damage will be unavoidable. With a view to protecting ecosystems, moderating electricity demand, and so forth, efforts to lower the temperature of the Tokyo metropolitan area by such measures as reducing energy consumption and recovering green spaces would seem to be necessary in the future.

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Chapter 4
The Current Status of and Prospects for Biodiversity in Tokyo

Shinya Numata and Tetsuro Hosaka

Abstract Although Tokyo is relatively small in area, it has rich biodiversity that should be maintained through conservation efforts. Here, we review the current status of the natural environment and the biota, and then discuss the prospects for Tokyo's biodiversity. Tokyo has several different types of ecosystems, including urban, forest, agricultural, and oceanic island systems, which support different types of habitat specialists. The estimated total numbers of wild plant and mammal species in Tokyo are 4323 and 51, respectively. Species richness is relatively low in the Izu and Bonin Archipelagos, but island endemism is high. The intensities of the four principal pressures directly driving biodiversity loss in Tokyo are either constant or increasing over time. Biodiversity conservation has become a central concept for green space management by the Tokyo Metropolitan Government since 2012. Although nature conservation has had significant positive effects in maintaining biodiversity in urban and agricultural landscapes, the negative impacts of biodiversity on the quality of urban life have recently been identified as ecosystem disservices. Because most natural environments in Tokyo are influenced by human activities, promoting better public understanding of biodiversity is the key to formulating an urban planning framework for sustainable biodiversity management.

Keywords Biodiversity · Bonin Islands · Izu Islands · Satoyama · Secondary nature · Tama · 23 special ward district of Tokyo · Urban ecosystem

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4.1 Introduction

4.1.1 Biodiversity

"Biodiversity," a term coined only 30 years ago, refers to the multiformity of living organisms in terrestrial, marine, and other aquatic ecosystems. Biodiversity is the central issue in nearly all environmental concerns. At the 10th Conference of the Parties to the Convention on Biological Diversity (COP-CBD), held in Nagoya (Japan) in 2010, biodiversity was the keyword for the delegates' ongoing campaign.

Although the term "biodiversity" is becoming increasingly familiar worldwide, the concept remains ambiguous. For the CBD, biological diversity refers to the variability among living organisms in all habitats including, among others, terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part; this concept includes diversity within species, between species, and among ecosystems. Thus, biodiversity originally referred to the conditions supporting the great variety of life forms in diverse ecosystems.

Ecosystem services based on biodiversity provide a multitude of benefits to people (The Economics of Ecosystems and Biodiversity (TEEB) 2010). Evidence shows that biodiversity loss reduces the efficiency of ecological communities in: (1) capturing biologically essential resources; (2) producing biomass; (3) decomposing organic material; and (4) recycling biologically essential nutrients (TEEB 2010).

4.1.2 Current Status of Biodiversity

Mass loss of biodiversity is a global concern. Daily species' extinction rates are now up to 1000-fold higher than natural rates (International Union for Conservation of Nature (IUCN) 2016). Extinction of individual species, habitat destruction, land conversion for agriculture and other human uses, climate change, pollution, and the spread of invasive species are only some of the threats responsible for today's biodiversity crisis. The global biodiversity outlook issued by the Secretariat of the CBD (2014) emphasized that all major pressures on biodiversity are increasing.

A Japanese biodiversity outlook was published by the Ministry of the Environment of Japan (MoE) (2010) to provide a summary of the status of biological diversity in the country. The report identified four principal pressures (habitat change, abandonment of agricultural landscape management, pollution caused by the introduction of chemicals and invasive alien species, and climate change) that are directly driving biodiversity loss in Japan (Table 4.1). These crises have been addressed through a variety of responses, which have been partially effective. However, the socio-economic drivers of modern societies markedly limit the force of these responses.

Table 4.1 Four biodiversity crises in Japan (Numata 2014, after MoE 2010, 2012)

Crisis	Explanation
First crisis (created by human activities including development)	Negative effects caused by humans, such as the development of reclaimed land in coastal areas, deforestation, and overexploitation. Crises relating to ongoing declines in wild populations and the loss and deterioration of natural habitats for wild plants and animals are persisting.
Second crisis (created by reductions in human activities)	Effects related to the reduction or abandonment of human activities due to (1) changes in industrial structures or the use of resources, and (2) depopulation and the aging of human societies. These changes have reduced the management efficiency of *Satoyama* landscapes, which have become degraded. Habitat loss in these landscapes has caused local species extinctions and population size reductions among surviving taxa. Wildlife damage to agriculture and forestry is especially severe.
Third crisis (created by artificially introduced factors)	Human effects resulting from the pursuit of modern life styles; these effects include the introduction of alien species and potentially harmful chemical compounds into natural environments, causing changes to native biota and ecosystems that persist over the long term.
Fourth crisis (created by changes in the global environment)	Effects that result from changes in the global environment, including global warming, increased frequency and intensity of storm conditions, changes in precipitation, decrease in oceanic primary production, and acidification of seawater. These effects cause species extinctions and are particularly relevant in fragile ecosystems.

4.2 Natural Environments and the Current Status of Biodiversity in Tokyo

The administrative area of the Tokyo Metropolitan Government includes the 23 special wards area of Tokyo to the east, 26 cities to the west, and two outlying island chains (Izu and Bonin Archipelagos) (Figs. 4.1 and 4.2). Although Tokyo covers a relatively small area, it supports rich biodiversity that should be maintained through conservation efforts.

Tokyo has two ecosystem types: (1) urban, secondary forest, and agricultural (*Satoyama*) systems, and (2) oceanic island systems. The different types of landscape support different habitat specialists.

4.2.1 Wildlife and Threatened Species

The Bureau of Environment of the Tokyo Metropolitan Government (BE-TMG) (1998) listed 4323 and 51 species of wild plants and mammals, respectively, found in Tokyo (Fig. 4.3a). Species richness was relatively low on the Izu and Bonin Islands, but endemism was high. The environs of Tokyo supported 4323 wild higher plant species, 51 mammal species, 422 avian species, 30 reptile species, 18 amphibian species, 18 freshwater fish species, and 2648 insect species. Among the

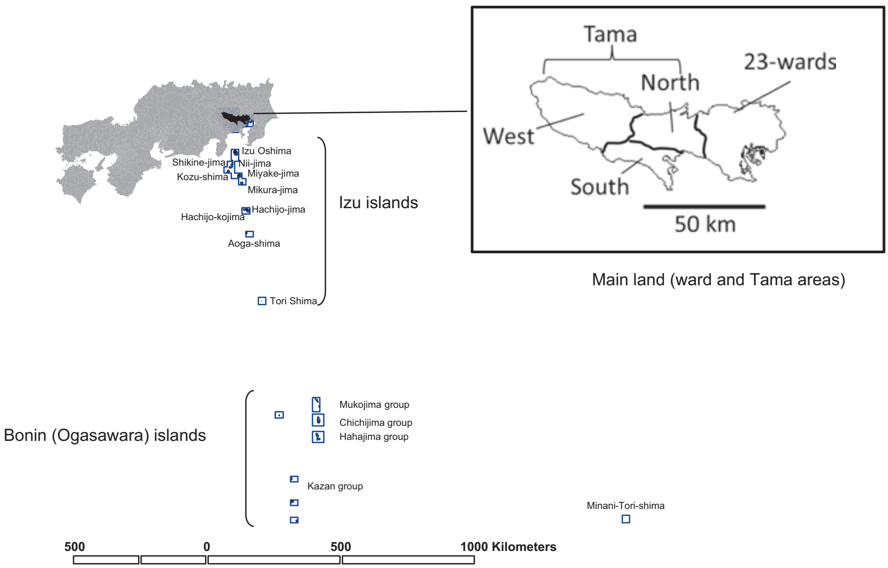

Fig. 4.1 Locations of the Tokyo Metropolis and the Izu and Bonin Archipelagos (Numata 2014)

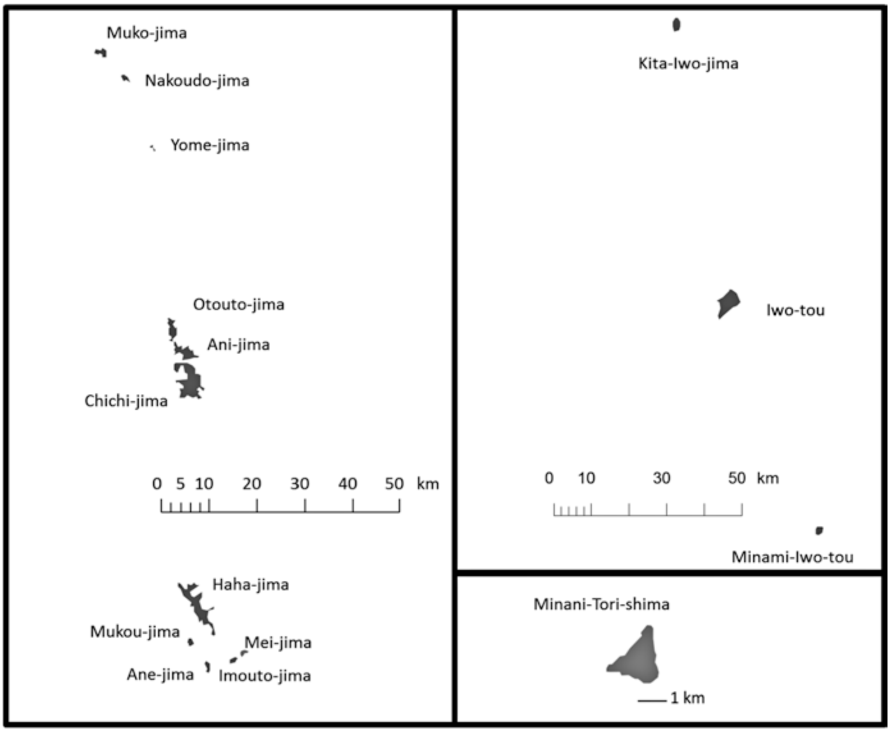

Fig. 4.2 Location of the Bonin Islands

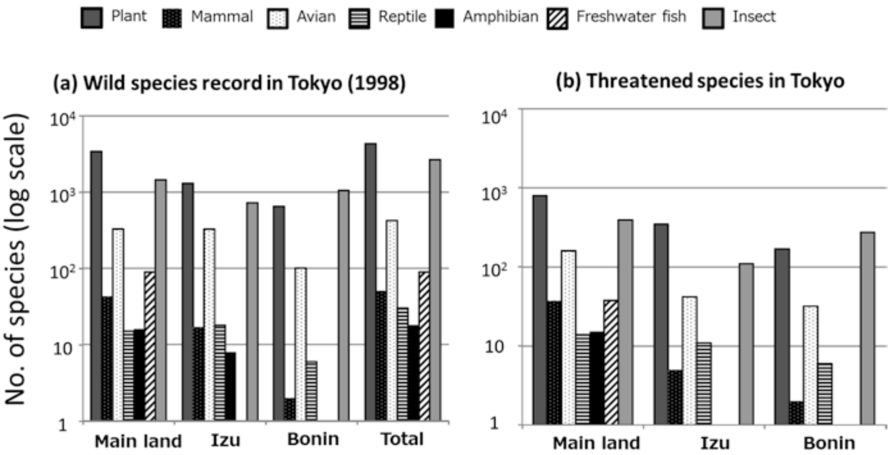

Fig. 4.3 Wildlife species in metropolitan Tokyo. (**a**) Numbers of wildlife species listed for mainland Tokyo and the Izu and Bonin Archipelagos. (**b**) Numbers of endangered wildlife species listed for mainland Tokyo and the Izu and Bonin Archipelagos (Numata 2014)

higher plants, 3421 species occurred on the mainland, 1313 on the Izu Islands, and 654 on the Bonin Islands. Among mammals, only one wild species (Bonin fruit bat: *Pteropus pselaphon*) was found on the Bonin Islands, whereas 43 species occurred on the mainland. Evidence shows that wild species have either been extirpated in Tokyo or exist in small, threatened populations. Hence, monitoring is essential to keep track of surviving taxa.

The BE-TMG (2010, 2011) listed threatened wild species in Tokyo, including 800 mainland plant species (Fig. 4.3b). Of these, 182 (22.8%) species have been recognized as threatened by the MoE. The Tokyo Metropolitan Government listed 384 threatened plant species on the Izu Islands; of these, 99 were listed as threatened by the MoE (BE-TMG 2011). The Tokyo Metropolitan Government listed 169 threatened species of plants on the Bonin Islands; among these, 35 species were listed as threatened by the MoE (BE-TMG 2011).

Among the threatened mammal species, 37, 5, and 1 occur on the mainland, the Izu Islands, and the Bonin Islands, respectively. The Japanese wolf (*Canis lupus*) and the Japanese river otter (*Lutra lutra nippon*) are now extinct on the mainland.

Eight-hundred mainland plant species have been listed as either extinct (68 species) or threatened (BE-TMG 2010). Among the latter species, 9 and 24 are listed as IA (critically endangered) and IB (endangered), respectively, by the MoE.

Small and mid-sized mammals were found in the city center area before the Second World War, but 20 species, including the Japanese water shrew (*Chimarrogale platycephala*) and the red fox (*Vulpes vulpes japonica*), are now considered extinct. Many mid-sized mammals, including the masked palm civet (*Paguma larvata*) and the raccoon dog (*Nyctereutes procyonoides*) occur in the North and South Tama areas. Common and threatened mammals, such as the Asian black bear (*Ursus thibetanus*), the stoat (*Mustela ermine*), and the Japanese serow (*Capricornis crispus*), occur in West Tama in the montane sector of Chichibu-Tama-Kai National park.

4.2.2 Protected Areas in Tokyo

Three national parks and one quasi-national park are located in the Tokyo administrative area. Chichibu-Tama-Kai National Park is located at the intersection of Saitama, Yamanashi, Nagano, and Tokyo Prefectures. The park contains eight peaks over 2000 m high, scattered over 1250 km^2 of terrain, with numerous hiking trails and ancient shrines. Fuji-Hakone-Izu National Park is a collection of dispersed tourist sites that dot Yamanashi, Shizuoka, and Kanagawa Prefectures and the western Tokyo Metropolis. The total area is 1227 km^2. The park includes Mount Fuji, Fuji Five Lakes, Hakone, the Izu Peninsula, and the Izu Islands. Ogasawara National Park is located on the Ogasawara (Bonin) Islands *ca*. 1000 km to the south of Tokyo. The park was established in 1972 within the municipality of Ogasawara, which is part of Tokyo. In 2011, the Ogasawara Islands were included in the UNESCO World Heritage List.

Meiji no Mori Takao Quasi-National Park is located around Mount Takao in Hachioji City, Tokyo. Established in 1967 for the centennial celebrations of the accession of Emperor Meiji, it is the smallest of the quasi-national parks. Mount Takao, rising to 599 m above sea level, is a massif of low mountains that formed in the Mesozoic era. The area supports dense pristine forests of momi fir (*Abies firma*), Japanese red pine (*Pinus densiflora*), and Japanese beech (*Fagus crenata*).

4.2.3 Mainland

The mainland area of Tokyo is divided into the 23-ward (east) and Tama (west) areas (Fig. 4.1). The highest concentration of urban zones is within the 23-ward area. Natural and secondary vegetation, including subalpine conifer forest, broad-leaved deciduous forest, broad-leaved evergreen forest, and plantations, are predominant in the western part of mainland Tokyo (Fig. 4.4). Most land is urban, and only 0.1% (42.4 ha) of the 23-ward area supports natural forest, secondary vegetation, or tree plantations (BUD-TMG 2008). The proportional covers of forest and agricultural land in the Tama area are 48.7% (56,458 ha) and 5.5% (2590 ha), respectively (BUD-TMG 2009).

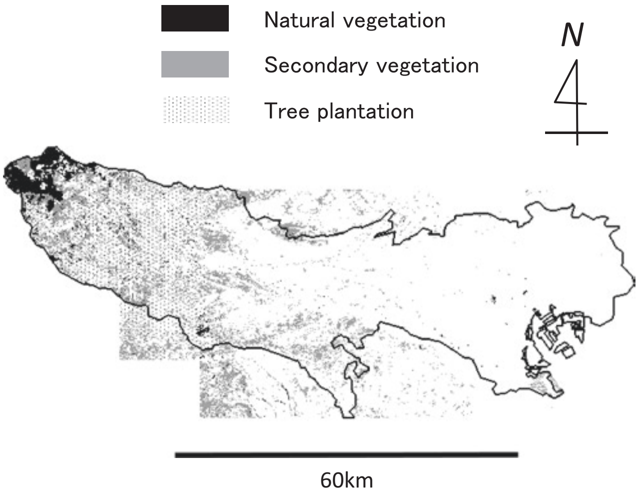

Fig. 4.4 Vegetation map of mainland metropolitan Tokyo. Natural and secondary vegetation (subalpine coniferous forest, broad-leaved deciduous forest, and broad-leaved evergreen forest zones) and plantations are indicated. Data sourced from the results of the Sixth and Seventh Vegetation Surveys conducted by the Ministry of the Environment of Japan (Numata 2014)

4.2.3.1 The 23-Ward Area

An urban ecosystem dominates the 23-ward area, where the natural vegetation would have been temperate evergreen forest. Little natural or semi-natural vegetation occurs in housing and factory areas (Fig. 4.4). The urban ecosystem is unique, but poor in biota because of habitat destruction, pollution, and overuse of natural biological resources (Puppim de Oliveria et al. 2011). The imperial residence and urban parks in the central ward area contain large-scale natural or semi-natural environments. Wild species have been recorded within the imperial residence area: 1366 wild plant species, 69 avian species, and a few mid-sized mammals, including the masked palm civet and the raccoon dog, have been reported there (Endo et al. 2000; Koyama et al. 2000; Takeda et al. 2000).

4.2.3.2 Tama Area

Forests occur in the Tama area. Many are secondary stands of deciduous oaks and plantations of cedar trees (Fig. 4.4). Natural stands that include climax species of temperate deciduous forests (*Fagus creanata*) have a limited occurrence in west Tama. The post-war new town development of Tama had significant effects on the natural environment. The development included the *Satochi-Satoyama* sector, which contained managed secondary forests of deciduous oaks (*Quercus serrata* and *Q. acutissima*), agricultural land with rice paddies and dry fields, artificial lakes, ponds, and grasslands before the Second World War (Numata and Obara 1982). Many secondary forests of deciduous oaks were reconfigured to residential land during the Tama new-town development in the 1960s (Miyawaki 1986). Ichikawa et al. (2006) examined changes in the *Satoyama* landscape, located in the urban fringe of the Tokyo metropolitan area, during the period 1880–2001. They found that in the Tsurukawa area (Machida, Tokyo): (1) the cover of woodland and agricultural land began to decrease rapidly by 1961; (2) large-scale development increased during the 1960s and 1970s; (3) the decrease in woodland and agricultural land cover slowed after 1974, but the rate of urbanization (conversion to urban land) remained unchanged after 1974; and (4) urban land use was predominant (60% of the total area), with large-scale development accounting for 6.1% of the area in 2001; woodland, crop field, and paddy field cover decreased to 20%, 7.4%, and 1.1% of the total area, respectively.

4.2.4 Izu Islands

The Izu Islands are volcanic; two of the islands, Hachijo-jima and Aoga-shima, are oceanic. The flora of the Izu Islands is part of a vegetation zone that includes the Izu peninsula and the Hakone volcano. However, ocean currents isolate the islands, which have floristic elements that differ from those of the Izu and Boso peninsulas (Miyawaki 1986). Differences in geological history and area account for the variation in vegetation and plant species richness among the islands (Table 4.2).

Although some differences exist among the islands, climax evergreen forests with *Castanopsis sieboldii* and *Machilus thunbergii* occur throughout the Izu Archipelago (Kamijo and Okutomi 1993). The vegetation of the evergreen forests, which differs from that of the Honshu mainland, is characterized by the absence of

Table 4.2 Areas and numbers of vascular plant species on 11 islands of the Izu Archipelago (Numata 2014, data from Kachi 2011)

Areas and Island	Area (km^2)	Numbers of vascular plant species[a]
Izu Oshima	91.1	806, 662, 777
To-shima	4.1	609, 282, 552
Nii-jima	23.9	639, 290, 505
Shikine-jima	3.9	357, 164, 322
Kozu-shima	18.9	546, 389, 642, 577
Miyake-jima	55.4	551, 600, 647
Mikura-jima	20.6	527, 528, 516
Hachijo-jima	69.5	662, 702, 786
Hachijo-kojima	3.1	
Aoga-shima	6.0	358, 253, 215
Tori-shima	4.8	95, 91

[a]Estimates separated by commas are from multiple sources

indigenous oak species (Miyawaki 1986). Anthropogenic impacts (Oyama 1999) and diverse stages of plant succession (BE-TMG 2011) also characterize the Izu Islands.

A distinctive biodiversity feature of the archipelago is the high number of endemic and sub-endemic species (Miyawaki 1986). Eighteen vascular plant species, 21 variant species, 1 variety, and 1 hybrid are endemic to the islands (Oba and Akiyama 2002).

The terrestrial mammalian fauna of the archipelago is poorer than that of the Honshu mainland. Nineteen mammal species, including the Japanese sea lion (*Zalophus japonicus*), are found in this area. Five rodents and shrews may have been artificially introduced (Takada et al. 1999, 2004). Other mammals, including the Taiwan squirrel (*Callosciurus erythraeus thaiwanensis*), the Formosan rock macaque (*Macaca cyclopis*), Sika deer (*Cervus nippon*), the Japanese weasel (*Mustela itatsi*), and goats (*Capra hircus*), may also have been introduced. Five mammal species, including the greater horseshoe bat (*Rhinolophus ferrumequinum*) and the large Japanese field mouse (*Apodemus speciosus*), are listed as threatened species (BE-TMG 2011).

4.2.5 Bonin (Ogasawara) Islands

The oceanic Bonin Islands are part of a remote Japanese archipelago in the northwestern Pacific Ocean. More than 30 islands and rocks belong to three islands groups: the Mukojima, Chichijima, and Hahajima groups. The three Volcano Islands (Ioretto) and three small, isolated islands (Nishinoshima, Minamitorishima, and Okinotorishima) are sometimes regarded as members of the Bonin Archipelago (Figs. 4.1 and 4.2). The climate of the Bonins is subtropical; the mean monthly temperature range on Chichijima is 18–28 °C. The monthly rainfall range is 60–170 mm, and the annual precipitation is *ca*. 1300 mm.

The biota of the Bonin Islands is distinct from that of the Honshu mainland (Miyawaki 1989; Hata and Kachi 2011). The islands have been less impacted by anthropogenic effects than have other islandsnear Japan mainland. Prehistoric remains (*ca*. 800–2000 years old) have been found on Kitaiwo-to (one of the Volcano Islands) and Chichi-jima (Kawakami and Okochi 2010). Prehistoric peoples disappeared prior to the recent human repopulation of the archipelago in 1830. Members of the second wave of settlers were European and Polynesian. A whaling industry existed around the islands (Kawakami and Okochi 2010), and farmland replaced some of the forests. Domestic animals, such as goats, were introduced to the islands and eventually became feral.

Vegetation and plant species richness differ across the archipelago due to the diversity of bedrock, geological history, and island area (Fig. 4.2; Table 4.3). The degree of plant species endemism is high: 69 endemic plant species (67% of the flora) occur in lowland dry forests. However, natural disasters and the elevated browsing pressure from feral goats have become major threats to the vegetation of

Table 4.3 Areas and numbers of vascular plant species on 14 islands of the Bonin Archipelago (Numata 2014, data from Kachi 2011)

Area (km^2)		Numbers of vascular plant species[a]
Muko-jima	2.6	127, 141
Nakoudo-jima	1.6	98
Otouto-jima	5.2	104, 186
Ani-jima	7.9	129, 185
Chichi-jima	23.8	313, 355
Haha-jima	20.2	254, 279
Mukou-jima	1.5	81, 89
Ane-jima	1.4	43, 82
Imouto-jima	1.2	63, 98
Mei-jima	1.1	39, 76
Kita-Iwo-jima	5.6	113, 129
Iwo-tou	23.2	100, 92
Minami-Iwo-tou	3.5	103, 129
Minani-Tori-shima	1.5	52

[a]Estimates separated by commas are from multiple sources

the islands. *Rhododendron boninense* is one of a group of rare plant species with population sizes smaller than 100 individuals. Two wild mammal species have been recorded on the islands, but one of them, the Bonin pipistrelle (*Pipistrellus sturdeei*), is now extinct, leaving the Bonin fruit bat (*Pteropus pselaphon*) as the only extant wild mammal. This species is listed as critically endangered (CR) by the MoE. The bat sometimes becomes an agricultural pest because its habitat overlaps human dwelling spaces (Inaba et al. 2002). Some of the island avian species are also threatened by habitat degradation. However, Bryan's Shearwater (*Puffinus bryani*), which was considered to be extinct, was rediscovered in 2012 (FFPRI 2012). The endemic and threatened species on the islands highlight the ecological significance of the Bonins.

Mesic forest (*Elaeocarpus-Ardisia*), with trees greater than 20 m in height, is part of the diagnostic vegetation of the Bonin Islands. The islands provide a suitable habitat with good soil for tall tree species, including *Elaeocarpus photiniaefolius* and *Pisonia umbellata* (Shimizu 2003). Another diagnostic vegetation type is a low, dry forest with trees 5–8 m high. This vegetation occurs in habitats with thin, dry soils. The forest contains many shrubby tree species, including *Distylium lepidotum* and *Schima mertensiana* (Shimizu 2003). The beech family (Fagaceae) is notably absent from the Bonin Islands (Miyawaki 1989).

Low species richness, simple food webs, and high levels of endemism in the biota are typical characteristics of oceanic islands. Across five major islands in the Bonin Archipelago, 150 of 688 species of vascular plants are endemic. Southeast Asian elements are the major components of the flora with western origins. Polynesian elements are from the south, and Japanese mainland elements are from the north (Shimizu 2003). Some species advancing into the islands filled vacant niches and underwent adaptive radiation. The most remarkable example of adaptive radiation is found in the land snail genus *Hirasea* (12 species and 4 subspecies) (Tomiyama 1992). Each species has a particular shell shape that is adapted to a specific habitat (Shimizu 2003). Small, remote oceanic islands generally lack indigenous land mammals and amphibians.

4.3 Perspective on Biodiversity in Tokyo

4.3.1 Biodiversity Crisis in Tokyo

The four principal drivers of biodiversity loss are listed in Table 4.1 (MoE 2010). Pressures from these drivers are either constant or increasing within the environs of Tokyo.

The first biodiversity crisis in Tokyo was serious before the Second World War, but has receded in recent times. Large- and mid-sized mammal species (e.g., Japanese red fox and Japanese hare [*Lepus brachyurus*]) were found in the city center until the 1930s (Kishida 1934), but habitat loss caused by rapid modernization and the catastrophic damage inflicted during the war eliminated most of these species. After the war, small mammal populations were impacted by large-scale development in the Tama area (Chiba 1973). Most of the woodlands in the north Tama area had disappeared by the 1970s (NCB-MoE 1976).

Interest in green spaces and natural environments in urban areas increased after the 1980s, following a period of rapid economic growth and rising pollution. In 1972, the Tokyo Metropolitan Government issued new regulations for nature protection and recovery in Tokyo. The 10-year project for green spaces in Tokyo, launched in 2007, encouraged the improvement of "green road networking" and "Umino-mori" ("forest in the bay") (BE-TMG 2007).

A conflict between humans and wildlife has emerged in green spaces. The ranges of some large- and mid-sized mammal species are expanding. For example, the ranges of wild boars have expanded considerably in West Tama, where damage to agriculture has become a serious issue. Some outdoor pests (e.g., wasps) have become a major problem in Tokyo (Hosaka and Numata 2016). Reducing conflicts with pests and appropriate science communication on the value of biodiversity are critical for sustainable biodiversity conservation in urban areas.

A weakening of the relationship between human beings and the *Satoyama* landscape through increased use of fossil fuels and chemical fertilizers is a second major crisis in Tokyo. The species composition and structure of managed forests used for agricultural purposes in *Satoyama* landscapes have changed, creating a biodiversity crisis in Japan. The endangered cherry species Tamano Hoshizakura (*Cerasus tamaclivorum*), for example, is found in *Satoyama* landscapes of the South Tama area (Ohara et al. 2004). Appropriate management of secondary forests by periodic logging and mowing will be important for the conservation of this species (Iki et al. 2014).

Satoyama management activities have been undertaken by local community groups. Volunteer-based management by these groups is recognized as an effective tool for mitigating the degradation of *Satoyama* woodlands (Kobori and Primack 2003). However, the problem of human aging is becoming a crucial issue in maintaining the staff required for management activities (Oku 2010). Participation by new members may be essential for the continuation of volunteer-based management by local community groups.

The alien species problem is the third crisis of special importance in the Bonin Islands. The direct impacts of alien species on endemic rare taxa are well known, and measures to control invaders have been implemented. The indirect impacts of alien species, e.g., pollination failure in indigenous plants, have also been emphasized recently (Abe et al. 2008; Abe 2009).

Problems caused by invasive species have been reported in mainland Tokyo. Although there is little quantitative information on the abundance of alien species in mainland Tokyo, Kitazawa (2010) detected significant increases in the numbers of alien plant individuals and species in four prefectures within the Kanto area. Some invasive species, such as the common raccoon (*Procyon lotor*), have caused serious problems through damage to agriculture by the vectoring of infectious diseases.

4.3.2 Strategies and Actions for Biodiversity Conservation

The outcomes of COP-10 have had great impacts on the policies and practices for conserving and managing biodiversity in Japan. The MoE established the National Biodiversity Strategy 2012–2020 with five goals: (1) raising public awareness of biodiversity; (2) developing human resources and a collaborative framework; (3) creating regions linked by ecosystem services; (4) national land conservation and management that accounts for the dwindling human population; and (5) strengthening the scientific knowledge base for the development of political measures (MoE 2012).

Based on the National Biodiversity Strategy and the Basic Act on Biodiversity enacted in 2008, the Tokyo Metropolitan Government established a new green plan in 2012 to function as a regional biodiversity strategy. The plan aims to create 1000 ha of new green space by increasing urban park areas, coastal forests, wayside trees, and school yards with lawns (BE-TMG 2012). Furthermore, 11 of 62 districts (i.e., wards, cities, towns, and villages) in Tokyo had established their own regional biodiversity strategies by March 2015 (MoE 2015). These strategies aim to promote: (1) public understanding of biodiversity issues; (2) conservation of native species and their habitats; (3) control of alien species; (4) networking among the lay public, companies, institutions, and governments; and (5) community development through conservation activities. Thus, biodiversity conservation has become a central concept for green space management in Tokyo.

The private sector has also initiated new actions related to biodiversity. A 3600-m^2 *Satoyama* forest was created alongside office buildings and a shopping complex in Otemachi in 2014 to mitigate heat-island effects and improve ecological networks in the city center. The forest supports 280 plant species, of which 160 were growing naturally one year after the forest was developed. The *Satoyama* attracts 8 and 66 species of birds and insects, respectively (Taisei Corporation 2014). the non-profit organization Ginza Honeybee Project keeps 150,000 honeybees on a rooftop in Ginza and collects 840 kg of local honey annually, aiming to strengthen public social networks and raise awareness of local biodiversity (Ginza Honey Bee Project 2016).

4.3.3 Ecosystem Disservices and Challenges

Although nature conservation has had significant positive effects on the maintenance of biodiversity in urban and agricultural landscapes, the negative impacts of biodiversity on the quality of urban life have recently been identified as ecosystem disservices (Lyytimäki and Sipilä 2009). Ecosystem disservices include allergen emissions, damage to human infrastructures, and people afflicted by falling branches, fear of and stress related to shaded green areas during darkness, and populations of pests and nuisance animals (Gómez-Baggethun and Barton 2013). Though most of these nuisances may be minor, they could be relevant to the quality of urban lifestyles and present challenges for biodiversity conservation activities (Lyytimäki et al. 2008). For example, human–wildlife conflicts may increase as green spaces expand within the urban or residential areas of western countries (Kretser et al. 2008; Soulsbury and White 2015). In Tokyo, the numbers of consultations on wasps, which account for 50% of total pest consultations, are higher in districts with high proportions of forested areas (Hosaka and Numata 2016). Local governments may face problems in handling the increasing numbers of consultations on wild animals in urban areas. Hence, the minimization of ecosystem disservices and the maximization of ecosystem services will contribute to sustainable biodiversity conservation. Public perceptions of ecological services and disservices are affected by many factors, including social and cultural contexts, and can be changed through education, interpretation, and media coverage (Lyytimäki and Sipilä 2009; von Döhren and Haase 2015). Thus, relevant scientific knowledge and environmental education, including information on the ecological functions of wild animals and appropriate ways of interacting with them, may greatly reduce the perceived disservices. Since most natural environments in Tokyo are influenced by human activities, promoting public understanding of biodiversity is the key to formulating an urban planning framework for the sustainable management of biodiversity.

4.4 Concluding Remarks

Tokyo, the capital of Japan, is one of the world's largest cities. It spans the 23-special wards district to the east, 26 cities to the west (Tama), and 2 outlying island chains (Izu and Bonin Archipelagos). Although Tokyo is relatively small in area, it has rich biodiversity that should be maintained through conservation efforts. "Biodiversity" has become a key element in urban landscape design and in the management efforts of national and local governments, private companies, and citizen groups. The ecological disservices of wildlife, such as an increasing frequency of conflicts between wild animals and residents in urban areas, should not be overlooked. Appropriate scientific communication on biodiversity is the key to reducing ecosystem disservice levels.

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Chapter 5
Satoyama Landscapes in Tokyo

Lidia Sasaki

Abstract Tokyo is well known for its modern urban landscapes, but in the suburbs and the broader metropolitan area, "islands" of traditional rural landscapes still survive, although under increasing pressure from urbanization. The present study aims to introduce the traditional Japanese *satoyama* landscapes and to examine not only the vital role they played in the development of Japanese rural communities but also their continued relevance in the contemporary context of global environmental change. The first part of the study, based on extensive literature review, explores various definitions of *satoyama* and *satoyama* landscapes, and identifies their key features and the range of ecosystem services and benefits these multi-functional landscapes used to provide to Japanese rural communities. After briefly exploring the historical context of *satoyama* development, the study examines the demographic, socio-economic, and cultural processes that led to the decline of *satoyama* during the past decades. The dominant forces identified are the process of suburbanization, on the one hand, and the abandonment of rural land management on the other. The second part of the study focuses on recent approaches to the conservation and revival of *satoyama* landscapes: first, the grassroots citizen movements for the management and alternative use of *satoyama* landscapes; second, the national strategies and regional policies adopted so far to revitalize these multifunctional rural spaces. The study uses examples from the western fringe of the Tokyo metropolitan area, where a network of *satoyama* landscapes survive and are locally preserved. These are communities where a combination of local policies and citizen involvement has resulted in the successful revival of local *satoyama* landscapes, and where alternative uses (recreation, environmental education, etc.) are promoted: positive examples with the potential for implementation in other areas. Conservation and revival of *satoyama* landscapes pose major challenges in the years to come. In the countryside, efforts to address the decline of *satoyama* landscapes need to be coordinated with broader strategies to revive rural communities throughout Japan. In the context of major urban concentrations, surviving *satoyama* landscapes represent strategical resources that could have a vital contribution to mitigating the impacts of climate change or natural disasters, making their conservation an urgent

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priority for sustainable development in the twenty-first century. The study stresses the need for increased public awareness and citizen involvement in *satoyama* conservation. At the broader level, a long-term vision and an integrated strategy, on the one hand, and cooperation at various levels, on the other, are key to *satoyama* landscapes' revival in the future.

Keywords *Satoyama* · Ecosystem services · Tokyo metropolitan area · Suburbanization · Multifunctional landscapes · Conservation

5.1 What Is *satoyama*?

Narrowly defined, the term *satoyama* (literally, "mountains surrounding villages" cf. *sato*: village; *yama*: mountain) refers to secondary woodlands and grasslands around rural settlements, traditionally used as commons to provide timber, fuel, compost, and fodder to local communities (Takeuchi et al. 2003).

In recent decades, however, the term has been used in its broader sense: "*satoyama* landscape is a mixture of forests, wet rice paddies, cultivated fields, pastures, streams, ponds and irrigation ditches, surrounding a Japanese farming village – the entire landscape necessary to supply the needs of a community" (Kobori and Primack 2003a, b). The Japanese Ministry of the Environment (MoE) defines *satoyama* as an area "consisting of secondary forests, paddies, farmlands, grasslands and irrigation ponds around settlements." It "includes about 800 million ha of secondary forests and about 700 million ha of other types of agricultural areas, accounting for up to 40% of the national territory of Japan" (Morimoto 2011).

The recent Japan *Satoyama Satoumi* Assessment (hereinafter JSSA) (2010) concisely defines *satoyama* as "a dynamic mosaic of managed socio-ecological systems producing a bundle of ecosystem services for human well-being" and adds the "traditional land […] management practices that have allowed the effective use and maintenance of these landscapes by the Japanese people" as a vital element of the *satoyama* culture (JSSA 2010).

In the Paris Declaration on the *Satoyama* Initiative (2010), the MoE proposes the broader term "socio-ecological production landscapes" (SEPLs) for such traditional landscapes, which can be found in many areas of the world. Comprehensively defined, these are "dynamic mosaics of habitats and land uses that have been shaped over the years by the interaction between people and nature in ways that maintain biodiversity and provide humans with goods and services needed for their well-being. These landscapes have proven sustainable over centuries and are considered living examples of cultural heritage" (IPSI 2010).

5.2 *Satoyama* Landscapes: Key Features

In its broader sense, therefore, the word *satoyama* is used to describe the traditional Japanese rural land-use systems and landscapes, the result of traditional land management by local rural communities over the centuries (Takeuchi 2010); cultural landscapes encompassing both the natural and cultural diversity of a region and the history of their interaction (Miyaura 2009).

Historically, self-sufficient Japanese rural communities depended largely on *satoyama*: this "mosaic of different ecosystem types" (Duraiappah and Nakamura 2012) used to provide a broad range of ecosystem services to the local communities, which developed traditional management techniques and a sustainable system for the cyclical use of natural resources within the carrying capacity and resilience of local ecosystems.

Over the centuries, intricate patterns of mosaic land use emerged, finely adjusted to the local natural conditions (landforms, climate, soils, and vegetation): paddy fields in the floodplains and on terraced slopes, dry fields on the upper flat terraces, and grasslands and forests on the uplands and on slopes (Figs. 5.1 and 5.2).

Among the various ecosystem services provided by *satoyama* are: supplying vital goods (timber, fuel, fodder, compost/fertilizer, food, and water) and regulating environmental conditions (water cycling, flood control, slope protection, soil formation, and climate control). Furthermore, the mosaic of land uses offers habitat

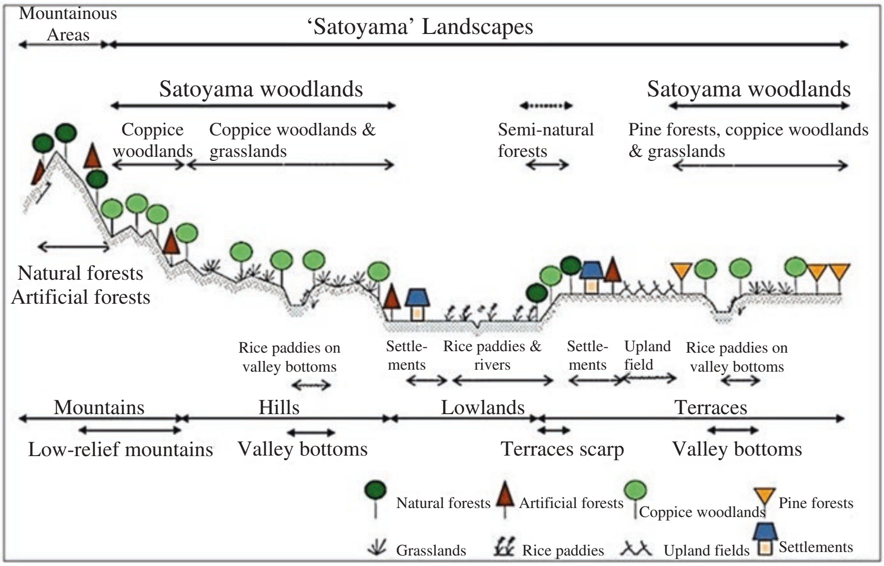

Fig. 5.1 Schematic representation of *satoyama* and *satoyama* landscapes (Yamamoto 2001)

Fig. 5.2 Typical *satoyama* landscape in Onoji, Machida City (July 2016)

for the rich biodiversity of *satoyama* landscapes, “a key element for their resiliency and proper functioning” (JSSA 2010).

This combination of goods and services supports human well-being and translates into economic benefits for communities, but *satoyama* landscapes also provide cultural and spiritual services, which have played a vital role in the emergence of Japanese people’s identity (Kalland and Asquith 1997).

According to the combination of natural environmental factors and the local farming/forestry/water management systems, a diversity of *satoyama* landscape types emerged over the centuries that can be identified throughout Japan (Duraiappah and Nakamura 2012).

5.3 *Satoyama* Transition After World War II

Satoyama landscapes have been, thus, supporting sustainable human communities for centuries, but the dramatic changes that occurred during the second half of the twentieth century proved to have long-lasting negative impacts. The disintegration of the close relationship between Japanese human communities and the natural environment since the 1960s was engendered by a convergence of internal and external factors.

Among the internal factors are the advent of modern agriculture and forestry, which resulted in less dependence on and under-utilization of local *satoyama* resources. This was compounded by a general trend of rapid rural population decline and aging, generating a chain reaction whereby farmland and forest management was abandoned, resulting in the degradation of *satoyama* landscapes on a massive scale.

Modernization of the farming sector after World War II was made possible by the use of fossil fuels and chemical fertilizers, reducing dependence on and the use of *satoyama* resources. Concurrently, farmland consolidation and mono-cultural land-use for improved productivity and efficiency eliminated the small acreage mosaic land-use pattern of the original *satoyama* landscapes. This situation was exacerbated by government regulations in the 1970s to downsize rice production, resulting in the abandonment of paddy fields, the destruction of ditches and irrigation ponds, and the reduction of the overall farmland area (Kobori and Primack 2003b). In the urban fringes of major cities, abandoned paddy fields were subdivided and converted into housing estates and other suburban uses (Kikuchi 2007).

Satoyama forests faced a similar fate: after World War II, to support the country's reconstruction efforts, modern forestry was implemented: the native forests in higher mountain areas were converted into coniferous tree plantations for intensive timber production, a process which irreversibly altered the landscape. Furthermore, starting in the 1960s, the decline in rural labor, on the one hand, and the supply of cheap imported timber, on the other, resulted in the mismanagement and degradation of these plantations (JSSA 2010). In many areas, these mono-culture plantations have disrupted key ecosystem services, such as adequate water supply, flood prevention, and slope protection.

Management of most *satoyama* coppice forests (with firewood and charcoal no longer needed) was also abandoned, resulting in the unchecked succession towards dense broad-leaved evergreen forests (the potential natural vegetation in most of Japan); furthermore, in abandoned *satoyama* forests, bamboo took over, vigorously expanding and causing the decline of ecosystem services and biodiversity (Miyaura 2009). "The increase in dense woodlands can be seen as a barometer of *satoyama* landscape neglect" (Takeuchi 2010).

A major factor contributing to *satoyama* degradation is the rural socio-demographic transition, manifested in the aging and the decline of the rural population. Rural population decreased from 45% of total population in 1970 to 33% in 2010 (Ministry of the Agriculture, Forestry and Fisheries (MAFF) n.d.), but the decline in farming population has been even more drastic: from 45.2% of the total population in 1950 to 6.4% in 1990 (Tsunekawa and Bessho 2003); furthermore, in 2007, 32.4% of the farming population was over 65 years old and only 5% were under 35 years old (MAFF n.d.). Consequently, it has become increasingly difficult to cultivate and maintain rice paddies or to manage forests, which are thus being abandoned.

Concurrently, external forces started manifesting as pressures for development. Urban population growth and urbanization gained momentum in the 1960s–1980s, during Japan's period of vigorous economic growth, resulting in the rapid urban expansion in *satoyama* areas on the outskirts of major cities. Land use changes and conversions occurred on a massive scale, mainly affecting *satoyama* woodlands, which became prime locations for "new towns" (large-scale public housing estates) and various other uses (golf courses, etc.).

The suburbanization front generally followed transportation corridors (railways and major roads) and leap-frogged to *satoyama* areas, where suitable land became available for development. Development proceeded mostly uncontrolled, with few zoning restrictions and little planning, in a typical urban sprawl pattern. Public policies to regulate urban development within designated areas, while preventing further development in *satoyama* areas, proved ineffective due to the speed and scale of development (JSSA 2010).

Vast stretches of *satoyama* were, thus, lost to urbanization. Toda (2006) estimates that about one third of *satoyama* land was lost nationwide in the three decades from 1960 to 1990, peaking in the period of rapid economic growth 1960–1970s, during which approximately 60,000 ha of *satoyama* were urbanized every year (Morimoto 2011). Kobori and Primack (2003a) report that the *satoyama* area in Yokohama decreased from 10,000 ha in 1960 to only 3000 ha in the early twenty-first century; more recently, in the Tokyo metropolitan area, approximately 1400 ha of farmland was lost in the decade 2000–2010 (Tokyo Metropolitan Government n.d.). Currently, the suburban development trend continues, although at a slower pace, proceeding mainly as infilling in areas left undeveloped during the previous waves of urbanization.

Due to such dynamic land use change around major cities, fragmented patches of (mostly abandoned) *satoyama* forest survive only in areas less accessible or unsuitable for development; some are protected by local ordinances to serve as parks or urban green belts (Kikuchi 2007).

Conversely, in the deep countryside, the situation of abandoned *satoyama* forests and farmland is rapidly deteriorating and the *satoyama* landscape itself "faces extinction" (JSSA 2010).

5.4 The Making of Tokyo's *satoyama*

Situated in central Japan, in the southern area of the broad Kanto region, Tokyo and its metropolitan area extend over four land units: the coastal plain, the uplands, the hills, and the mountains (Kaizuka 1979).

The plateaus and hills, with alternating narrow valleys and higher ground, thick layers of volcanic ash (the Kanto Loam), relatively fertile soils, and moderate climate with ample precipitation, offered favorable conditions for the early evolution of farming communities and the development of typical *satoyama* land use systems and landscapes. In the mountains on the western border of the Kanto region, the combination of cultivated river terraces and the slopes under dense forest cover has supported self-subsistent rural communities for centuries.

The origins of most *satoyama* landscapes in the Kanto region date back to the Edo/Tokugawa period, a time of rapid population growth and village expansion. Throughout the Kanto area, most of the original forests were replaced early on by secondary deciduous forests, traditionally managed as commons (*iriaichi*): coppice forests (based on the forest cycle of 10–20 years, used for production of charcoal, fuel, timber, compost, fodder, and food) and bamboo groves (providing construction materials, food, etc.). Concurrently, villages in the western Okutama Mountains were known for producing timber and charcoal for the ever-growing urban demand, and well-managed *satoyama* forests maintained a steady supply over the centuries.

Farmland, meanwhile, gradually expanded, with the typical mosaic of land uses characteristic of *satoyama* landscapes. One such example is the Musashino countryside west of the city (nowadays a green residential area), where the creation of the Tamagawa Canal in the seventeenth century provided irrigation water from the Tama River to this previously water-poor area. This enabled land reclamation, the creation of new villages, and, over time, the gradual emergence of a typical *satoyama* landscape, a rich mosaic of oak coppices and upland fields (vegetables, orchards, tea plantations, and commercial crops to supply the city markets) (Komeie 2010).

Until the end of World War II, Kanto region's *satoyama* landscapes supported sustainable local rural communities, which remained the major suppliers of farm and forest products to the expanding city of Edo (Tokyo).

5.5 *Satoyama* Transition in the Tokyo Metropolitan Area

A comparison of land use in the Kanto region between 1880 and 1990 reveals the major changes that mark the *satoyama* landscape transition. While, in 1880, forest and woodlands covered 49% of the area, in 1990, their area had declined to 17%. The situation for dry fields and rice paddies is similar, with a decline from 15% in 1880 to 8% in 1990. Conversely, built-up areas expanded from 2% to 62% over the same period (Takeuchi et al. 2003).

This situation is largely explained by the rapid urban expansion of Tokyo, especially after World War II. Kikuchi (2008a) documents the mechanism of urban sprawl and the outward movement of Tokyo's urban fringe. While, in 1976, the urban fringe was within a 30-km radius of the center, in 1997, following expansion mainly along transportation networks radiating away from central Tokyo and in areas where land became available for development (mainly *satoyama* areas), the urban fringe was pushed further out (Hachioji, in the western fringe, is located around 40 km away from the city center) (Fig. 5.3).

One typical example of the scale of development is Tama New Town on the western outskirts of Tokyo, where an area of approximately 2000 ha of *satoyama* in the Tama Hills was cleared and flattened for the construction of major public housing estates and other facilities in the 1970s–1980s.

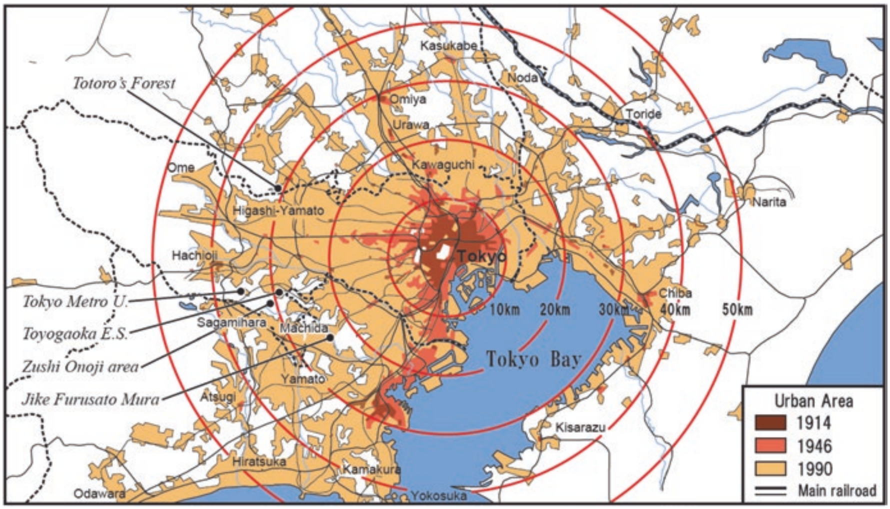

Fig. 5.3 Expansion of the Tokyo metropolitan area (Kikuchi 2008b) and location of the case studies (added by the author)

Analyzing these changes, Kikuchi (2008a) observes that "as a whole, the spatio-temporal changes of the Tokyo metropolitan urban fringe from 1976 to 1997 have been characterized by an outward movement, with local differences that depended on such factors as land conditions, transportation networks, accessibility to the metropolitan center, socioeconomic activities, infiltration of an urban lifestyle and city planning."

In some areas of the inner fringe, measures to control the urban sprawl resulted in local regulations to conserve *satoyama* farmland as "productive green land," using a preferential land tax system (on condition that the land use should remain unchanged for 30 years). On the outer fringe (Machida, Hachioji, Kodaira, and Tachikawa), areas where such measures were not taken, local farmers had to rely on various strategies to survive urban pressures, such as intensive farming (multiple cropping and greenhouses) or lower intensity, labor-saving agriculture (Kikuchi 2007); therefore, in these areas, urban farmland is fragmentarily conserved.

Conversely, *satoyama* forests on the urban fringe did not enjoy the same privileges. While farmland, considered a vital resource, was protected as productive green land, forests did not receive preferential tax status; with the change of generation, expensive inheritance taxes were levelled on forest land, forcing inheritors to sell, and thus encouraging the spiral of land use changes and further suburban development (Kikuchi 2008b).

Consequently, on the inner fringe, ex-*satoyama* forests became the prime location for large-scale residential estates, while on the outer fringe *satoyama* forests were replaced by a typical mix of undesirable uses: graveyards, garbage processing facilities, disreputable hotels, gambling parlors, etc.; meanwhile, in abandoned *satoyama* forests, illegal garbage dumping (bulky electric devices, cars, etc.) became widespread.

5.6 *Satoyama* Landscapes Conservation: Case Studies from the Tokyo Metropolitan Area

The present study is illustrated with examples from the western fringe of the metropolitan area, where a network of *satoyama* landscapes survive and where local conservation activities, combined with recreation and environmental education, have the potential to become models of multifunctional use of *satoyama* resources on the urban fringes.

The first example is the area of Sayama Hills in Tokorozawa City, on the western fringe of the metropolis (40 km from the city center), which is a green island of typical *satoyama* landscapes expanding over 3500 ha, and exceptionally well preserved, despite tremendous pressures for development since the 1970s. The area is a refuge for many species of wildlife and has a remarkably high biodiversity, but it also conserves valuable cultural heritage: 114 shrines, 235 sites of ancient villages, etc. (Kobori and Primack 2003b).

In the 1930s, two water reservoirs (Sayama Lake and Tama Lake) were created in the area; simultaneously, part of the surrounding forests, owned by the Tokyo Metropolitan Government, gained protection status.

The traditional farming system in the area was based on small-scale mixed cultivation of rice (single crop paddy fields along the floodplain), wheat, barley, potatoes, vegetables (double cropping system), and the famous Sayama tea on the higher terraces, upland fields, and gentle slopes (Fig. 5.4); traditionally, each farm had 1–1.5 ha (Kikuchi 2007).

The forests covering the hill slopes were used for firewood, charcoal, and compost production, and traditionally managed by trimming off low branches, cutting down undergrowth and, regularly raking the fallen leaves to keep the forest floor clear; since the 1970s, such activities have been neglected, resulting in uncontrolled ecological succession and ecosystem degradation (Kikuchi 2007).

With the decline in rural population, forest and farmland were put on the market; with the shift in land ownership, the area has seen a massive wave of conversions to urban uses (residential, recreational, etc.) promoted by local land use zoning regulations.

Without conservation efforts, the entire area would have been rapidly converted into residential and/or industrial projects. Since 1990, the Totoro Hometown Foundation, modelled on the British National Trust, has played a leading role in conserving the forest environment, rural land use, and *satoyama* landscapes in the area. Totoro is the benevolent forest spirit in director Hayao Miyazaki's animated movie "My Neighbor Totoro" (1988), a story set in the Sayama Hills; it became a beloved symbol of *satoyama* forest conservation activities throughout Japan.

The Foundation initiated the Totoro Hometown Fund Campaign in 1990, which proceeded in four stages. First, public donations were collected with the purpose of acquiring forest land for conservation. With these contributions, the fund has managed to acquire 40 patches of forest to date (Fig. 5.5). The recent creation of a membership system aims to provide continuous financial support for conservation activities (Totoro Hometown Foundation n.d.).

Fig. 5.4 Typical *satoyama* landscape in the Sayama Hills (Kikuchi 2008b)

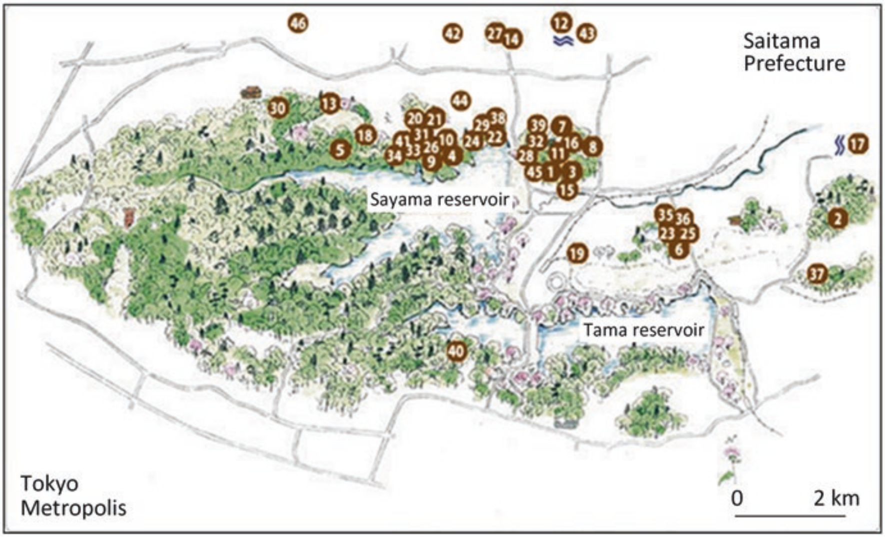

Fig. 5.5 Map of Totoro's Forest: location of conservation forest patches (sourced from the Totoro Hometown Foundation's website)

This was followed by the call to restore *satoyama* through various citizen activities, aiming to rehabilitate traditional landscapes under the guidance of local farmers. Among the farmland management activities promoted were the rehabilitation of rice paddies and water reservoirs, and rice cultivation/harvesting; meanwhile, the promoted forest management activities included planting trees, mowing grass, cutting trees/branches, and removing undergrowth.

At a later stage, researchers and residents worked together to gather information on the biodiversity, cultural historical background, and traditional land management practices of the area, ultimately producing a comprehensive inventory.

Finally, an environmental education program was implemented, providing guided tours, wildlife watching, hands-on farming experiences, and seasonal harvest events, mainly to local citizens and school children.

Participants from various backgrounds cooperate on these projects with different motivations. Urban citizens participate as a means to enjoy rural recreation, for the associated health benefits and also to help preserve the good residential environment shared by all; many of them also highlight the nostalgic feelings of belonging they experience in the countryside. For rural residents, on the other hand, such activities provide an opportunity to conserve their valuable cultural and spiritual heritage, and preserve a sense of identity. The wide cooperation on this project contributes to the diversification of local social networks, and the area "represents a node to connect rurality and urbanity" (Kikuchi 2008a) in the urban fringe.

The area is an increasingly popular destination and the number of visitors has been growing in recent years, mostly from neighboring urban/suburban communities (Fig. 5.6). Favorite activities are walking and hiking, whereby visitors also enjoy the health benefits of "forest therapy," and participating in activities organized by the local visitor center (guided walks, photography classes, etc.).

While the Foundation's activities have not stopped urban encroachment, which slowly continues in the area, this grassroots movement of *satoyama* conservation has greatly contributed to raising awareness of the issue, becoming a model for local citizens' involvement subsequently emulated by other similar groups.

Our second example of a rural community conserving traditional *satoyama* landscapes is Jike in Yokohama City, Aoba ward, on the south-western outskirts of the metropolitan area. A thriving farming community since the Edo/Tokugawa times, its traditional *satoyama* landscape combined rice paddies, ponds and irrigation canals, vegetable dry fields, orchards, and patches of coppice forests, managed according to the local know how.

Since the 1960s, population loss has been accompanied by the gradual shift to part-time farming and commuting to urban jobs; abandonment of farming in households in which the younger generation is not involved in farm management is also common (Kikuchi 2010).

These trends were reversed in the 1980s, when Yokohama City financed the restoration of irrigation infrastructure in the area and started offering tax incentives and subsidies for local farmers contributing to the conservation of the traditional landscape, under the name *Jike Furusato Mura* (Jike Hometown) Project. The project

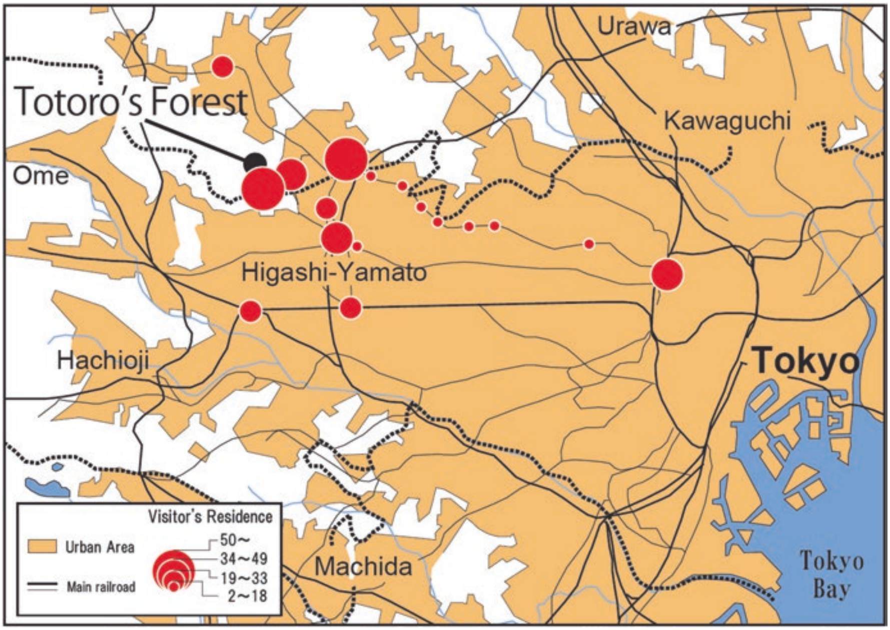

Fig. 5.6 Map of the origin of visitors to Totoro's Forest (Kikuchi 2008b)

has attracted the active involvement of volunteer groups in traditional land management and conservation activities, under the guidance of local farmers (Fig. 5.7).

Land uses reflect this trend: agricultural land use has been essentially perpetuated, with productive functions somehow diminished and farmland maintained for its complementary functions: landscape amenity, conservation of ecosystems and biodiversity, green space (as part of the green belt), cultural heritage conservation, and health-enhancing recreation opportunities (including hobby farming) (Kikuchi 2010).

The area is attracting increasing numbers of visitors, offering a diversity of recreation facilities, such as networks of marked paths, information boards, benches, parking lots, a fishing pond, etc. The visitor center *Shiki no Ie* ("House of the Four Seasons") provides information on the local *satoyama* environment and traditions, and organizes activities such as guided tours, insect- and bird-watching, photography and pottery courses, traditional cooking classes, festivals, and other events; the restaurant offers food made from local produce (Jike Furusato Mura Shiki no Ie n.d.). Visitors enjoy rural recreation through walks, nature observation, friendly exchanges with farmers, or shopping for fresh agricultural produce; they also learn about the local natural environment and rural landscapes. In this context, various patterns of partnership, collaborative actions, and interaction between farmers and urban citizens have developed, contributing to a sustainable relation between rurality and urbanity in this area (Kikuchi 2010).

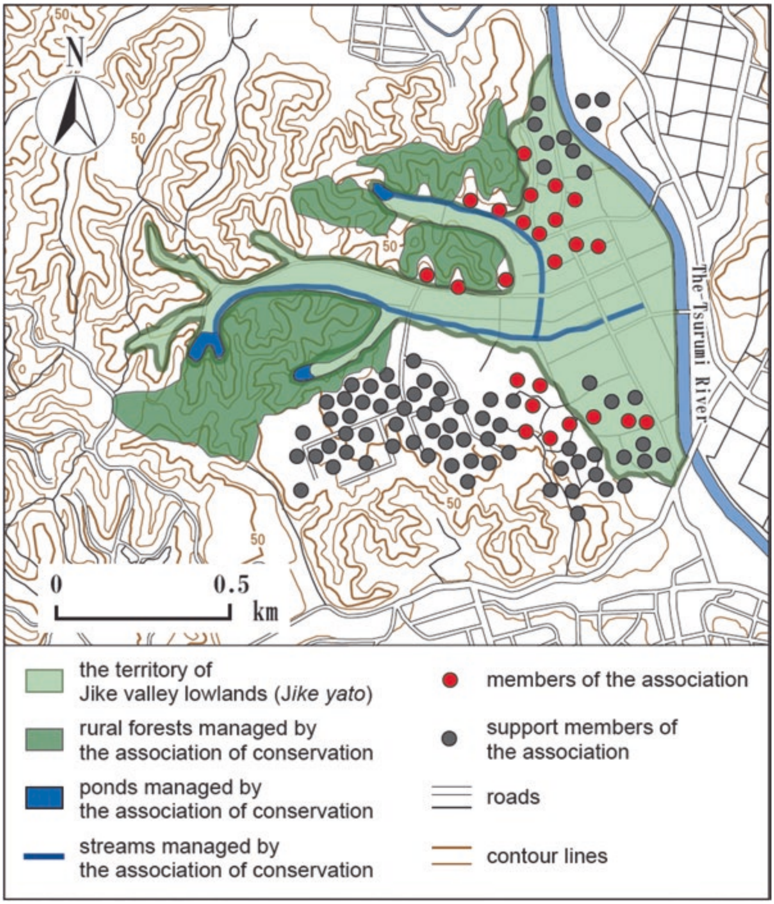

Fig. 5.7 Jike Furusato Mura: *satoyama* conservation activities (Kikuchi 2010)

Zushi Onoji Historic Environmental Conservation Area in Machida City, on the outer fringe of the metropolis, provides a third example of successful *satoyama* conservation. Lying 30 km south-west of central Tokyo in the Tama Hills, Machida is one of the rapidly growing suburban residential areas; developed since the 1970s, it has seen a 6.6-fold increase in population over the past 50 years (Machida City 2002).

Zushi Onoji area has a long history and rich rural traditions; it preserves an intricate mosaic of traditional land uses such as coppice woodlands, dry vegetable fields, rice paddies along *yato* (narrow valleys at the head of local rivers), irrigation ponds, etc., as well as a few beautifully restored old farmhouses and temples.

The area's environmental and historical value was recognized by the Tokyo Metropolitan Government in an ordinance in 1978, in which 36 ha were declared as the Zushi Onoji Historic Environmental Conservation Area. Early efforts for conservation were hampered, however, mainly by national legislation to reduce rice acreage in the 1970s. During the 1970s and 1980s, management of farmland and forest was abandoned, resulting in uncontrolled ecological succession and deterioration of the environment (Kitagawa 2003).

The conservation efforts have been led by the local farmers, organized as a non-governmental organization, the Machida Historic Environmental Management Organization, since 1996, which was put in charge of *satoyama* management and landscape restoration work in the area, with a view to respecting traditional land management practices (Kitagawa 2003; Matsui et al. 2008).

The project's success was partly due to the implementation of tax incentives for the farmers involved, but also attributable to the broad partnership for *satoyama* conservation that includes the Tokyo Metropolitan Government, the Machida City administration, universities, researchers, and volunteers.

The ecological restoration project was effective, as indicated by the increased biodiversity of plant and wildlife species (Kitagawa 2003); consequently, the area has been recognized as one of the 100 best *satoyama* areas in Japan (Asahi Shimbun 2009).

This project's relevance is that it proved *satoyama* landscapes "are best managed following traditional procedures by local farmers" (Kitagawa 2003) (Fig. 5.8). The system works well and specialists evaluate that it has the potential to be implemented in other areas (idem).

Fig. 5.8 Zushi Onoji *satoyama* landscape (July 2016)

Acknowledging the project's accomplishments, the Machida City Master Plan (Machida City 2002) prioritizes conservation of the area and promotes management based on traditional know-how (of farming and forestry) accumulated over centuries by local farmers, for the following purposes: sustainable management within the environmental carrying capacity; the resilience of the local environment; biodiversity and traditional landscape conservation; conservation of water resources; and flood control. The plan also enforces some use restrictions: building industries and, to a lesser extent, public access and some recreation activities (Machida City 2002).

Recent developments in the area include the involvement of the NPO *Midori no Yubi* (Green Thumbs) and their footpath initiative: the group helps create local infrastructure for rural recreation, including rural paths, information boards, maps, etc.; in recent years, the footpath network has been gradually expanding and now connects the remaining *satoyama* areas in the western outskirts of the metropolitan area (Machida, Tama, and Hachioji City). Another positive recent development is the creation of the Onoji *Satoyama* Visitor Center, which has the potential to attract more visitors in the future (Machida City n.d.; NPO Midori no Yubi n.d.).

5.7 Multifunctional Use of *Satoyama* Landscapes

In many *satoyama* conservation areas, environmental education is a top priority: teachers and students from local schools are invited to study nature and biodiversity; they also participate in events for hands-on learning of traditional land management practices and traditional crafts (charcoal making and basket weaving), cooking, etc. (Koike 2014). Two examples illustrate this approach: one is Tokyo Metropolitan University (TMU); the other is an elementary school in Tama City (Tama New Town).

In Hachioji City, around 30 km west of the city center, Tokyo Metropolitan University conserves 13 ha of ex-*satoyama* coppice forest, which was in use until the late 1970s, when suburban development of the Tama New Town began. The forest is managed by the university as the Matsugi Hinata Green Conservation Area and is open to the public. It conserves diverse ecosystems, such as mixed forest on the slopes and aquatic and marshy ecosystems in the lower areas, which help maintain a high biodiversity. The inventory includes: 800 species of plants, with some rare flowering species, and various species of wildlife (insects, amphibians, birds, and eight species of mammals, among others) (TMU 2007) (Fig. 5.9).

The medium-term management plan proceeds according to detailed zoning and site-specific operations: while the western side is slowly reverting to the broadleaf evergreen forest, the potential vegetation typical for this area, other areas are managed as bamboo groves (Fig. 5.10) or maintained as coppices. The current management approach aims for the gradual transition back to the native vegetation (necessitating least human intervention).

The forest is used for educational purposes by the life sciences department, which has set several experimental areas and observation spots within the forest.

Fig. 5.9 Matsugi Hinata Green Conservation Area information board (July 2016)

Students were involved in compiling the inventory of biodiversity (TMU 2007) and continue monitoring the forest for various projects. Another recent educational program, which includes field trips to the forest, introduces *satoyama*'s natural and cultural features to international students.

Local citizens and school children are also invited for recreational and educational activities, as part of the university's outreach program. One such event, for example, combined bamboo shoots collecting with a lecture on the importance of continued *satoyama* management, contributing to raising citizen awareness of the issue.

A second example of a project combining *satoyama* conservation and environmental education can be found in Tama City (Tama New Town), on the western fringe of the metropolitan area, where Toyogaoka Elementary School is known for its progressive education for sustainable development (ESD) program, based on the school's "green resources": an ex-*satoyama* coppice forest and farmland (approximately 1 ha overall).

The coppice used to belong to the local temple, and was managed for charcoal production; with the development of Tama New Town in the 1970s, the forest was donated to the public elementary school (Fig. 5.11).

The forest is now used for environmental education (both curricular and extracurricular activities); within life science classes, students observe seasonal changes

Fig. 5.10 Matsugi Hinata Green Conservation Area on Tokyo Metropolitan University's campus (June 2016)

in the forest, learning about plant and animal life cycles, basic ecological concepts, and the importance of greenery in an urban environment (Fig. 5.12). Extracurricular activities also familiarize students with nature and develop their interest and sensibilities for nature, including art projects using forest products and active recreation (summer camp in the forest, etc.) (Sasaki 2008; Toyogaoka Elementary School n.d.).

The forest, which conserves rare flowering species and is home to a few species of wildlife (insects, birds nesting here, etc.), is managed by the school according to traditional *satoyama* management practices, with financial support from the local education board and in partnership with local community volunteers (parents, local citizens, researchers, etc.).The school also has other green educational resources (a paddy field, a vegetable plot, an orchard, and a lotus pond) where the students cultivate rice, vegetables, and fruit, learning hands-on farming skills.

In recent years, the school forest has gradually become a community forest, with organized tours for parents and local citizens, visits by children from the local nursery school, and other activities that facilitate community interaction and communication (Sasaki 2008). In recognition of its contribution to environmental education and to raising public environmental awareness, the school gained UNESCO Associated School status in 2010 (Toyogaoka Elementary School n.d.).

Fig. 5.11 Toyogaoka Elementary School forest (June 2007)

Fig. 5.12 Toyogaoka Elementary School: environmental education in the school forest (June 2007)

5.8 Perspectives on *satoyama* Conservation

Citizen movements for nature conservation in Japan started in the 1980s, on the wave of increased environmental awareness and citizen activism. Conservation activities tended to focus mainly on *satoyama* forests, where the ecological damage was becoming increasingly visible after 30 years of neglect. In the suburbs of major cities, the baby boomer generation started taking interest in the conservation of the surviving *satoyama* in their immediate surroundings.

In recent years, *satoyama* have seen renewed appreciation among urban citizens, for the multiple benefits and ecosystem services provided besides their productive uses: environmental, aesthetic, cultural, recreational, and spiritual.

In areas around large cities, conservation of ex-*satoyama* woodland and farmland is promoted as a system of management by citizen volunteer groups joining efforts with local farmers. In the early twenty-first century, Tsunekawa and Bessho (2003) estimated that there were approximatively 3000 groups engaged in *satoyama* conservation activities nationwide, with more than 20,000 volunteers involved, managing about 5% of Japan's remaining *satoyama* forests. In 2007, *satoyama* conservation activities were held at about 1000 sites, 60% of which are found around the three largest metropolitan areas (Tokyo, Osaka, and Nagoya).

While such efforts are to be commended, volunteer-based *satoyama* management cannot possibly provide for maintenance on a national scale, particularly in isolated hilly and mountainous areas, where entire *satoyama* landscapes are on the verge of ecological collapse.

Institutional approaches to *satoyama* conservation started in the late 1990s, but lack of a long-term vision and strategy, as well as of an integrative approach and cross-institutional cooperation, has hampered progress.

National efforts have been coordinated by the MoE. The "National Action Plan for the Conservation and Sustainable Use of Socio-ecological Production Landscapes (*satochi-satoyama*)" was launched in 2012, based on the principles emanating from the *Satoyama* Initiative (IPSI 2012). The plan stresses the need for a long-term vision and an integrated approach to conservation. It also proposes a new vision, whereby multifunctional *satoyama* landscapes should be "sustained through participation and cooperation of citizens in all positions, as a common natural resource that they share (i.e., "new commons" approach), to be handed down to future generations" (MOE 2012).

Priority is, therefore, given to increasing public understanding and awareness of *satoyama*'s significance and the need for its conservation, and to promoting participation by local citizens and communities (Kobori and Primack 2003a), while expanding engagement and cooperation at various levels. Specialists agree that a national effort is necessary: historically, "management of *satoyama* has traditionally built on involvement by entire communities" (Kohsaka et al. 2013); therefore, *satoyama*'s revival needs "a system of joint *satoyama* management: partnerships and improved synergies between farming and forestry households, local governments, businesses, NGOs, NPOs and urban residents" (Takeuchi 2010).

In an urban context, to support the long-term management of suburban *satoyama*, various strategies have been adopted by the Tokyo Metropolitan Government. Tokyo Vision 2020 (Tokyo Metropolitan Government 2007) proposes the ambitious goal to restore Tokyo to a beautiful city surrounded by water and greenery, and plans to create about 1500 ha of new greenery in the city. Specialists, however, highlight the need to prioritize conservation of authentic secondary environments (*satoyama*), instead of creating new artificial green spaces (Watanabe et al. 2012).

Tokyo's "Green Master Plan" (Tokyo Metropolitan Government n.d.), launched in 2007, aims to regenerate the city's rich greenery by means of replanting and also conserving existing *satoyama* areas. The plan proposes 50 sites for nature conservation (over 750 ha), mainly in the western suburbs, preserving natural, historical and cultural landscapes, including *satoyama* sites. Tokyo's Bureau of the Environment issues detailed guidelines for conservation activities (Tokyo Metropolitan Government 2015). The plan also calls for the involvement of local citizens/communities, volunteer groups, researchers, businesses and NGOs, universities, schools, and the metropolitan and local governments; however, it fails to offer concrete incentives for conservation.

Worried about the "approximately 1,400 ha of farmland which was lost in the decade 2000–2010" to suburban development, the Metropolitan Government's "10 Year Plan for Green Tokyo" (Tokyo Metropolitan Government 2007) recognizes the multiple roles that farmland plays in an urban setting and stresses the necessity for conservation. Concrete measures include, on the one hand, the creation of a system of public green areas of urban farmland, while, on the other hand, inheritance tax reductions are promoted, to enable forests to also be conserved. Furthermore, the plan proposes measures to improve forests in the mountain areas west of the city, by proper management and replanting.

The conservation and revival of *satoyama* landscapes pose major challenges in the years to come. In the countryside, a long-term vision and a comprehensive strategy to address the major decline in *satoyama* landscapes needs to be coordinated with efforts to revive rural communities throughout Japan.

In the context of major urban concentrations, surviving *satoyama* landscapes represent strategical resources that could make a vital contribution to mitigating the impacts of climate change or natural disasters. Their conservation should be an urgent priority.

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Chapter 6
The Religious Space of Edo, Considering the Distribution and Functions of Temples and Shrines

Keisuke Matsui

Abstract In this chapter, I examine the distribution, landscape and functions of temples and shrines in the city of Edo (premodern Tokyo); and evaluate the urban structures whose construction is based on the mystical and religious aspects of spatial design. A city design modeled on *Heian-kyo* (ancient Kyoto) was applied to the construction of the city of Edo, and was arranged according to the four directions and their connections with gods. Religion had two main functions: social maintenance and leisure activities. Regarding the social maintenance function, temples and shrines were under the control of the Tokugawa shogunate during the Edo period. They were integrated into the system of maintaining social order, playing a marginal role in the mechanism of the Tokugawa shogunate. Conversely, temples and shrines with spacious precincts developed into places of leisure, visited by the public to worship and enjoy eating, drinking, and relaxing walks, in addition to visiting on festival days and for annual events.

Keywords Religious space · Landscape of temples and shrines · Recreational space · Edo · Control of religion

6.1 Introduction

Tokyo is a huge city in which everything, including people, goods, capital, and information, is heavily centralized. Tokyo has been building its megacity since the latter part of the twentieth century (Kikuchi et al. 2013, 2014). Therefore, from the perspectives of urban landscape and function, Tokyo is indisputably the current central city of Japan. As is well known, from the ancient history of Japan, the Imperial Court in the Japanese Yamato period regarded Tokyo and its surroundings as a remote region. In fact, this region remained a "blank area" for a long period,

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since its development progressed much more slowly than any other place in the Kanto region (Tamura 1992). The emergence of Tokyo as a modern city can be traced back to the time when Tokugawa Ieyasu (the founder of the Tokugawa shogunate) entered Edo in 1590 (Tensho 18: Japanese calendar) and established the shogunate government (Tokugawa bakufu) in 1603 (Keicho 8). It is known that Ieyasu planned an urban structure based on a certain religious worldview in constructing the city of Edo.

This urban structure has been the subject of much research, mainly in the fields of historical science, folklore, and architecture (Naito A1966, Naito M1996, 2007; Miyamoto 1996; etc.). For example, on the principle of the composition of Edo, Akira Naito (1966) devised a spiral-shaped development diagram rotating clockwise around the Castle of Edo. Masatoshi Naito (1996, 2007) later pointed out the existence of a spatial design based on the Four Symbols (the four mythological creatures in the Chinese constellation), and interpreted the meaning of the magico-religious space structure as applied to urban constructions, including the location of the *kigan-ji* temple (Buddhist temple built for prayer) or the *bodai-ji* temple (the family temple of the Tokugawa family), and the construction of the Nikko Toshogu Shrine, all of which were promoted under the first three shoguns of the Tokugawa family. Based Masatoshi Naito's work, Miyamoto (1996) contributed his interpretation of the design of the religious city of Edo focusing on the role of Tenkai Sojo (a bishop) and his group of architects.

There are too many specific studies to enumerate all those concerning the urban construction of Edo. For example, Suzuki (1988, 2000) focused on the locational conditions of the artificial city of Edo and formed a detailed history of the city, especially the infrastructure development of water-carriage elements, such as the harbor and ship transportation. Moreover, Jinnai (1992) established a cosmology of "the City of Water," considering the space structure of Edo from the logical point of location. His paper examines the characteristics of Edo as a religious city based on the accumulated Edo-Tokyo studies.

Concerning the specific locations of temples and shrines necessary for creating grand designs with a religious worldview, example study topics include the following: the location of temples and shrines in castle towns (Shinoda et al. 2004); elucidating the change of temple-owned land in the temple towns of Yanaka and Nishi-Asakusa (Watanabe 2011, 2013); the morphological features of the precinct of temples and shrines (Tone et al. 2005); and land use in Tokyo, especially for religious purposes, from the end of the Edo period to the post-Meiji era (Masai 1975; Hong 1993). These studies empirically examined the relocation, existence, or abolition over time of those temples and shrines in modern castle towns, which were built in designated areas in accordance with the religious worldview and military requirements.

To understand the religious space of Edo, one should consider the various functions held by religious facilities such as temples and shrines, in addition to the location and distribution of religious facilities in relation to sacred space. More specifically, the temples and shrines were under the *Terauke-seido* (the system that compelled the public to become Buddhists), as part of the administration of religion by the Edo shogunate, and played a function necessary for engagement in social life through the *Danka soshiki* (Buddhist temple supporter system), while being strictly regulated by the *Jiin-hatto* (laws for temples) (Tamamuro 1971; Wakatsuki 1971). Concurrently, the areas of temples and shrines provided the Edo residents with recreational spaces for daytime use, where they could enjoy such amusements as cherry blossom viewing and fairs (Ono 1983; Shimomura and Egashira 1992; Kanbayashi et al. 2008). Temples and shrines were important facilities in providing leisure functions, as some of the most popular destinations for Edo residents (Ono 1987; Ohmiya et al. 1995; Hanyu and Okano 2003; Hanyu 2005).

Naturally, temples and shrines served as ritual places for Edo residents to perform rites requesting the fulfillment of earthly wishes from Shinto deities and Buddhas. Accordingly, various kinds of faith objects were created, such as Jizo (Kshitigarbha: the guardian deity of children), the god Inari, and the Seven Deities of Good Fortune, in addition to those of the existing religions. These folk beliefs were closely connected to the Japanese lifestyle (Miyata 1993; Kawai 2001; Miki 2001, etc.). This chapter will illustrate the religious space of Edo by focusing on the various functions it served.

In attempting to gain a deep understanding of the urban space of Edo, this chapter seeks first to understand the religious space of Edo by examining the distribution and landscape of the religious facilities (temples and shrines) forming the basis of the urban structure, considering their functions for urban residents with reference to existing research.

This chapter is organized as follows: The second section overviews the impact of geographic ideologies, such as the Principle of Proper Arrangement of the Four Guardian Gods and aspect divination, on the urban planning of Edo as a religious city. The third section describes the system of religious control by the Edo shogunate and the distribution and relocation of temples and shrines thereunder, from the viewpoint of religion as a system of social maintenance. The fourth section examines how the temples and shrines performed their functions as places of leisure by utilizing their locational characteristics, as arranged through spatial principles and shaped by the city's expansion.

6.2 Urban Planning of Edo, a Religious City

When Tokugawa Ieyasu entered Edo, the urban structure of Edo applied the Principle of Proper Arrangement of the Four Guardian Gods, according to *Onmyodo* (the way of Yin and Yang philosophy). This section provides an overview of urban planning based on the Arrangement of the Four Guardians and the religious structure of the castle city of Edo, referring to the work of Akira Naito (1966) and Masatoshi Naito (1996, 2007).

In *Ryuei Hikan*[1], which records annual rites, ancient rituals, and old customs, it is stated that Edo Castle is most suitable as the ruling castle for all of Japan and is

[1] Ryuei Hikan is a book written by Yamon Kikuchi, which records matters related to the Edo shogunate, concerning such issues as the rituals throughout the year, status in the Palace, historical events, old customs, and laws and regulations for the samurai class. The original (standard text) of this book comprises 10 volumes and was issued in 1743 (Kanpo 3).

constructed on a site amenable to the Four Symbols (the four mythological creatures in the Chinese constellations).

Thus, Edo Castle is the most suitable as the ruling castle for the entire nation, and its site is also suitable for each of the gods of the four directions. First, the ground to the front is levelled, and the low-lying part of Edo follows *Suzaku* (Vermilion Bird) to the front. Tokiwa-bashi, where a number of people gather, and the outflow of Takino-guchi are clean, and the left side represents *Seiryu* (Azure Dragon). The road for traffic use extends to Sinagawa and the right side, where Toranomon is located, represents *Byakko* (White Tiger). Yamanote (a hilly residential section) expands backwards and represents the force of the *Genbu* (Black Tortoise). The nation ruling castle features the three cores elements of castle, camps, and walls. Here, "the castle" refers to *Honjo* (the Main Castle) and the walls place chokepoints at about 40 km therefrom. This means that Hakone on the Tokaido (the Edo-period Edo-Kyoto highway) and the walls install strategic stops at a distance of about 140 km from the Castle. There are also strategic stops along the Tonegawa and Toridegawa Rivers in the direction of Senjyu. In the northern area, the mountain pass of Fuefuki is located: serving as a base of strategic stops and fortifying Edo in the area of approximately 8 km around (Naito M 2007).

Onmyodo in Japan considers the Gods of the Four Directions to be Azure Dragon, White Tiger, Vermilion Bird, and Black Tortoise. On the site where the Four Gods dwell, there is a flowing river in the east (Azure Dragon), a broad road in the west (White Tiger), a pond in the south (Vermilion Bird), and mountains/hills in the north (Black Tortoise). When the above conditions are met, such a site is considered to be auspicious and suitable for the placement of a city. This geographical principle can be widely seen in the East Asian cultural sphere, with the selection of sites and orientation of cities, villages, buildings, graveyards, and other geographical elements being based on the fortune-telling divination of the geographical features and surrounding space (Watanabe 1990, 1994, 2001; Shibuya 2005; etc.). Under the Principle of Proper Arrangement of the Four Guardian Gods, it is considered important that the site be bordered by mountains to the rear and water at the front. In other words, there should be a river to the east, a broad road to the west, mountains to the north, and a water source to the south. *Heijo-kyo* (ancient Nara) and *Heian-kyo*, two ancient capitals of Japan, are considered to be cities based on the Principle of the Proper Arrangement of the Four Guardian Gods. Researchers have sought to identify these two ancient capitals as cities based on the above principle. Although there are various opinions, in the case of *Heian-kyo*, the Kamogawa River is considered to be the Azure Dragon to the east, Ogura-ike (Ogura pond) the Vermilion Bird to the south, San'indo the White Tiger to the west, and Mt. Funaoka the Black Tortoise to the north. Thus, Kyoto is regarded as a site suitable for each of the gods of the four directions (Murai 1993; Mizuno 2007).

This Principle of Proper Arrangement of the Four Guardian Gods is also considered to apply to the urban planning of Edo.

Naito and other researchers believe that the avenues running north to south in Edo are biased towards the west, in comparison with those in *Heian-kyo,* because of the restrictions of the ground features in the Hibiya inlet and the Hirakawa River in

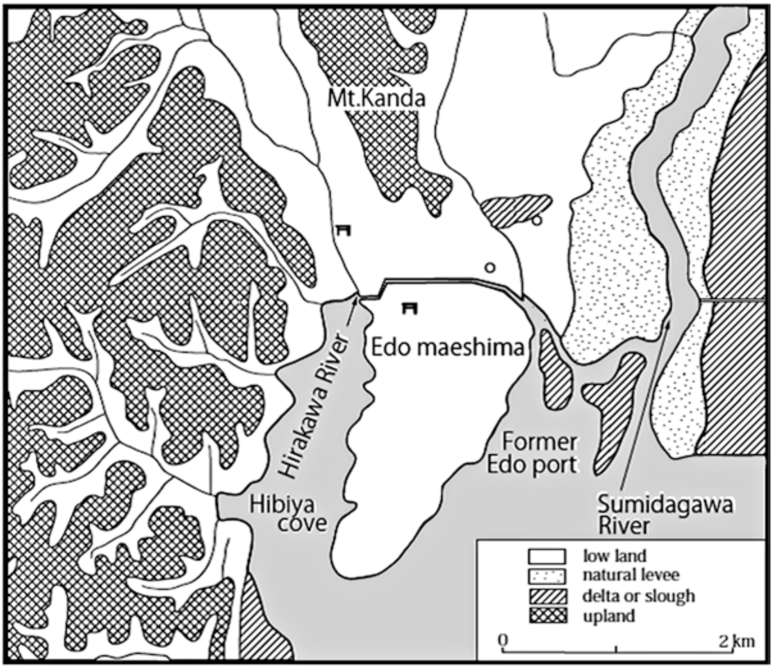


Fig. 6.1 Topographical map of Edo in the late sixteenth century (Suzuki 2000, translated into English)

Edo (see Fig. 6.1). Nonetheless, they identify the Hirakawa River as the Azure Dragon, Edo Bay as the Vermilion Bird, Tokaido as the White Tiger, and the Kojimachi Plateau as the Black Tortoise; concluding that the Principle of Proper Arrangement of the Four Guardian Gods is the standard of organization for the castle city of Edo. Although there may be many possible interpretations, the salient point is that the urban planning of Edo incorporates the spatial concept of defending the Castle by considering Hakone, the Rokugo River, the Fuefuki Mountain Pass, and other elements as natural formations, in addition to the Principle of Proper Arrangement of the Four Guardian Gods (see Fig. 6.2; Naito M 2007).

Developing this further, Masatoshi Naito has evolved an interpretation of the magico-religious space structure, including important religious facilities such as the *kigan-ji* temple or the *bodai-ji* temple, and the site of the Nikko Toshogu Shrine, which was constructed in a later period. Figure 6.3 shows the religious cosmology pictured by Masatoshi Naito. In 1590 (Tensho 18), soon after Tokugawa Ieyasu entered Edo, he declared that Senso-ji Temple (Tendai sect) be a *kigan-ji* temple and that Zojo-ji Temple (Jodo sect) be a *bodai-ji* temple.

These two ancient temples were, thus, selected as objects for these specific purposes. Senso-ji Temple is an ancient temple of the Tendai sect and has a long and honorable history of being highly revered by Genji (the Minamoto clan). It is also located at *kimon* (the northeastern, unlucky direction) of Edo Castle. In *Sensoji-shi*

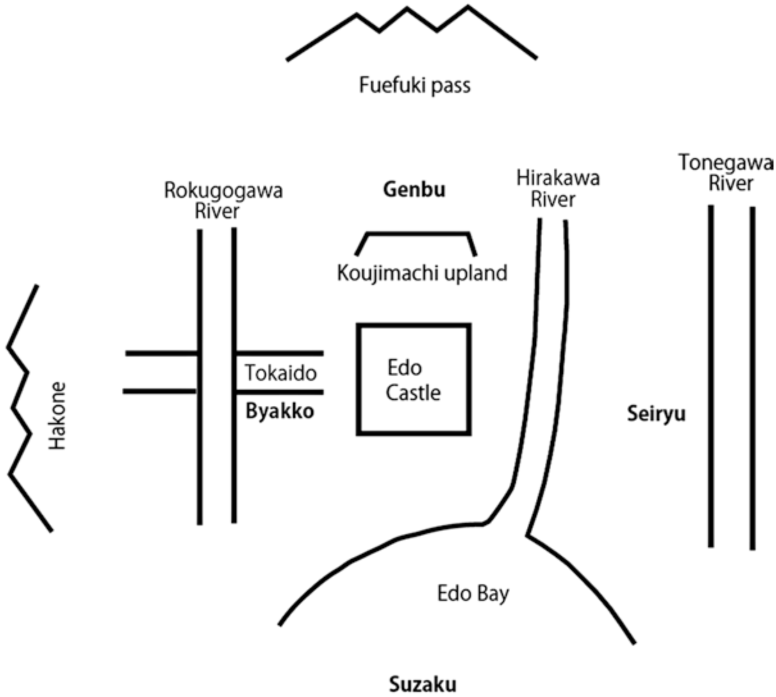
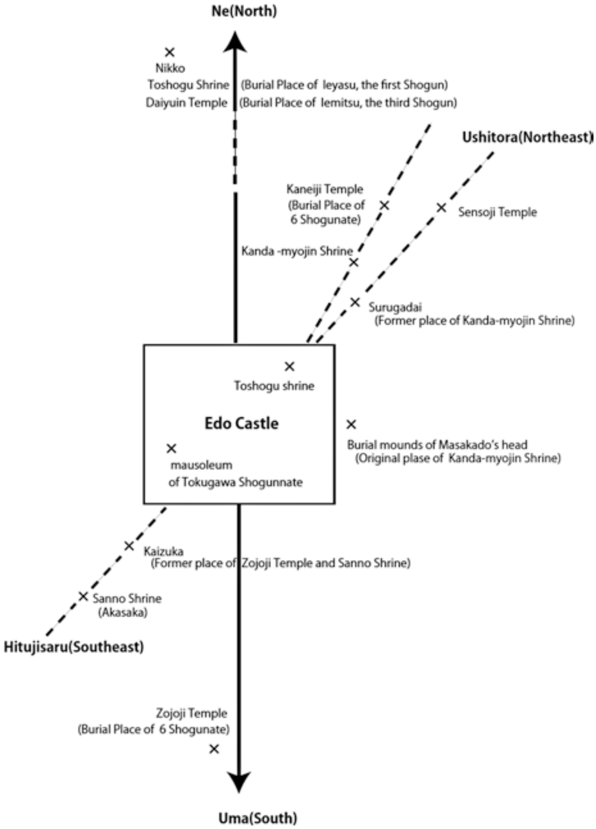


Fig. 6.2 Religious urban structure of Edo City from Naito M 2007 (Matsui 2014)

(History of Senso-ji)[2], it is mentioned that Senso-ji Temple was selected for the same reason. Zojo-ji Temple was originally placed at the rear demon's gate (southwesterly direction) in Edo, and then moved to its present site (Shiba) in the south of the Castle in 1598 (Keicho 3). This fortune-telling divination by direction may be the important perspective through which to examine the formation of the religious space of Edo. Tokugawa Ieyasu died in 1616 (Genna 2) and was deified as Tosho-daigongen. He is enshrined in Nikko, almost due north of Edo. The direction of due north, where the pole star is located, is an important direction as it administers the cosmos. Nikko's location was selected based on the *Hokuto hokushin* faith. Additionally, Tokugawa Iemitsu, the third shogun, constructed the Toeizan Kan'ei-ji Temple in 1625 (Kan'ei 2) as a new *kigan-ji* temple at the site of Ueno-Shinobugaoka, in the northeast direction of the Castle, after the historical Enryaku-ji Temple had been placed on Mt. Hiei, northeast of *Heian-kyo*. The urban design of Edo, as based on the magico-religious worldview, was even further multilayered. In addition to the

[2] Sensoji-shi is a book compiled by Kanzan Matsudaira, recording matters related to the Senso-ji Temple and its culture. This book was issued in 1813 (Bunka 10).

Fig. 6.3 Magico-religious cosmology of Edo City from Naito M 2007 (Matsui 2014)



Toeizan Kan'ei-ji Temple in the direction of the demon's gate (northeast), the Kanda Myojin Shrine (*Goryo* Shrine, meaning a kind of folk religious belief of avenging spirits), where Taira-no-Masakado was enshrined, was constructed as the *so-chinju* (the center place to pray for the local Shinto deity). Furthermore, the Sanno-jinja Shrine was relocated to the rear demon's gate for the purpose of protecting Edo Castle. Only at the festivals of Kanda Shrine and Sanno Shrine were their floats allowed to enter the Castle to submit to the shogun's inspection (Fig. 6.4).

These systems for expelling the impurities of Edo went beyond religious facilities. Along the roads at Senju and Shinagawa, in the direction of the demon's gate and rear demon's gate, places of execution were located at Kozukahara and Suzugamori, and red-light districts at Yoshiwara and Shinagawa. These sites formed unorthodox spiritual spaces. The magical urban protection system allocated unusual spiritual spaces to the most remote places of the urban area. This system may be important for our understanding of the spatial structure of Edo.

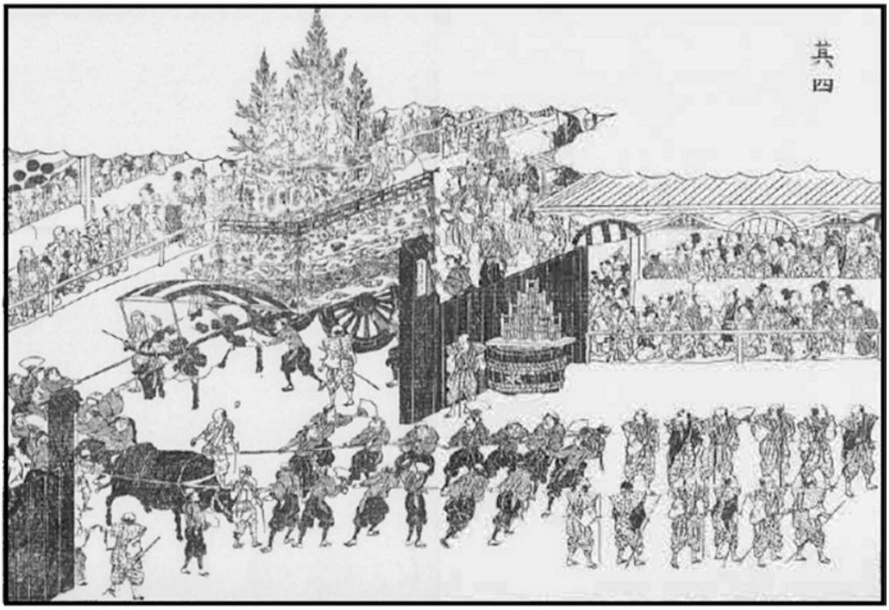


Fig. 6.4 Festival of Kanda-myojin shrine from "Edo Meisho Zue Vol.5" (Ichiko and Suzuki 1996)

6.3 Religion as a Social Maintenance System

6.3.1 The System of Religious Control of the Edo Shogunate

The Buddhist temples owned vast amounts of land called *jiryo* (temple estates) and considerable assets at that time, although their scale was modest compared with the times before the Age of Civil Wars. They were still formidable forces from a social, economic, and military point of view. Therefore, the Tokugawa shogunate made great efforts to bring these temples under its full control. The Hokke (Nichiren) and Ikko-shu (Jodo-shu) Buddhist sects had a strong base of religious faith supported by the common people. Thus, it was crucial for the shogunate to control these temples in order to stabilize its government. Religious control measures had been successfully implemented by Tokugawa Ieyasu from the Oda-Toyotomi government. Further, a new way of rearranging the temples was promoted by members of the shogunate ruling system, under the leadership of Konchi'in Suden.

The Tokugawa shogunate established *Jiin-hatto*, which outline its Buddhism Policy at that time. The purpose of these laws was to resolve disputes among the Buddhist sects and to control them.

The first *Jiin-hatto* was issued to Mt. Koyasan in 1601 (Keicho 6) and was established separately from prominent temples and sects until 1616 (Genna 2; Wakatsuki 1971). The Tokugawa government was not yet stable at that time and did not have sufficient power to control temples on a nationwide scale. The *Jiin-hatto* had wide-ranging content, covering the various sects of Buddhism. The laws' main provisions concerned organization of office; order of precedence; qualifications for being a chief priest; imperial sanction to *Kesa* (Buddhist stoles), including *Shie* (purple priest robes) and the title of Saint for a high priest; restrictions on *Jukai* (receiving religious precepts); rules of promotion; the relationship between head temples and branch temples; limitations on Buddhist sermons; control over temple solicitation and recruitment; limitations on building new temples; and the prohibition of heresy and new Buddhist sects (Wakatsuki 1971). It is thought that the purpose for instituting the *Jiin-hatto* was to firmly establish and strengthen the *Honmatsu-seido* (a system intended to control Buddhist organizations) and to force the royal family to confirm the superiority of the shogunate over them by displacing their privileges onto temples (Tamamuro 1971). The *Honmatsu-seido* intended to incorporate all temples of Buddhism into the shogunate system by seizing control over the head temple of each sect through the head's control over its branch temples. The strengthening of the relationship between head temples and their branches was promoted, along with a series of administrative measures, through the compilation of *Honmatsu-cho* (the book of relations between head and branch temples) and the establishment of *Jisha-bugyo* (magistrates of temples and shrines).

Another important religious measure of the Edo period was the *Terauke-seido*. This was a system established to root out any clandestine followers of Christianity. This system required every person to prove their Buddhist credentials by obtaining a deed called the *Terauke shomon* (certificate of a Buddhist temple). Bans against Christianity were issued frequently after the edict expelling Jesuit missionaries was issued by Toyotomi Hideyoshi in 1587 (Tensho 15), and Christianity was banned outright in 1612 (Keicho 17). The shogunate promoted an isolationist policy by taking advantage of the Shimabara War, which broke out in 1637 (Kan'ei 14). Subsequently, the shogunate ordered temples to maintain a *Shumon-Ninbetsu-Aratame-Cho* (equivalent of a modern family register) in 1664 (May, Kanbun 4). Through these maneuvers, people were forced into forging a relationship with a family temple as a committed Buddhist parishioner, establishing a system whereby the temples came to exercise very strong power over their parishioners.

The two systems of *Jiin-hatto* and *Terauke-seido* were the principal religious control measures implemented by the Edo shogunate, serving to hierarchize all of the country's temples and successfully estrange them from the world of politics by encouraging religious study. Thereby, the temples played a part in the terminal organization of the shogunate while being controlled by it. The *Terauke-seido* provided many temples with economic stability. However, this status contributed to the degeneration of Buddhism as a belief. Faced with a lack of parishioners and seeking to continue operating as *kigan-ji* temples, some temples encouraged visitors to pray for worldly wishes to be fulfilled, as well as setting days for unveiling a treasured Buddhist image or for fairs. It is thought that such diversifications caused the common people of Edo to have various relationships with religion. This phenomenon will be examined in the next section.

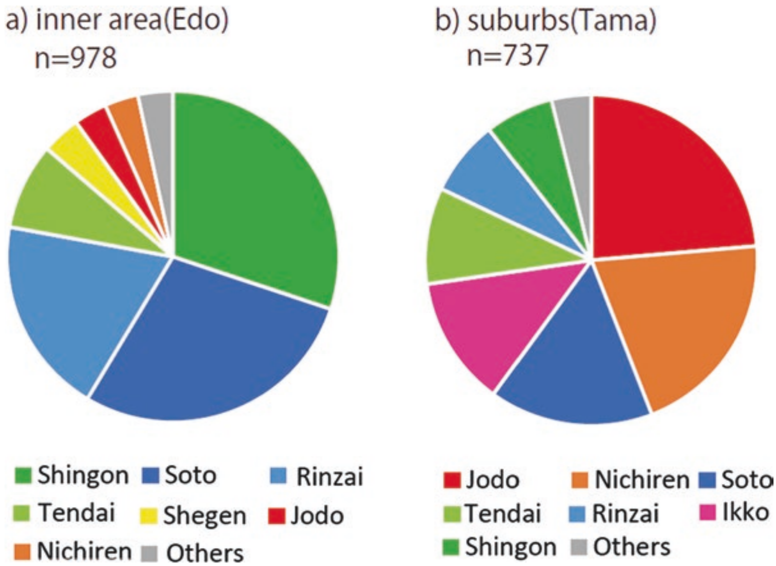


Fig. 6.5 Number of temples according to sect in Edo and suburbs (From Nitto 1998 and Naito A 1966)

6.3.2 Distribution of Temples and Relocation of Teramachi

As temples came to be incorporated into the governing organizations of the shogunate, they also functioned to share the burden of maintaining social order.

This status of temples greatly impacted the urban spatial structure, such as the distribution and location (establishment and relocation of temples) and the formation of *teramachi* (densely located temple areas). Estates owned by temples and shrines accounted for approximately 15% of the utilized land of Edo: the same amount of land as was owned by common people. According to the *Jiin Meisaibo* (Record of temples) of Meiji 5[3], as of 1872 (Meiji 5), there were approximately 2500 temples outside the city of Tokyo. Figure 6.5 shows the number of temples per sect recorded in the *Gofunai-bikou-zokuhen*[4], which was the research record of temples within Edo from the 18th to the early nineteenth century, and in the *Shinpen Musashi Fudo Kiko*[5], a topography of Musashi Province that recorded the number of temples per

[3] Jiin Meisaibo of Meiji 5 is a book compiled by the Ministry of Religious Educa-tion in each prefecture and jurisdictional area in 1872 (Meiji 5). The Ministry ordered contributors to prepare records on the history of each establishment; along with both the number and the personal histories of the monks and nuns of the temples of each sect.

[4] Gofunai-bikou-zokuhen is a dossier of history archives, which formed the foundation of the Gofunai-fudoki compiled by the shogunate during the era of Bunsei. The principal part of the dossier is the record of towns. The sequel dossi-er covers temples and shrines.

[5] Shinpen Musashi Fudo Kiko is the Fudoki (description of regional climate and culture) of Musashi Province. Its content included descriptions of temples and shrines.

sect outside Edo. Regarding the distribution ratio per sect of the number of temples in Edo, the Jodo sect had 231 (23.6%), and the Hokke sect 200 (20.4%). The numbers for these two sects are much larger than those of others: by comparison, the Sodo sect had 156 and the Ikko sect 124. Research reveals that in Tama-gun, in the suburbs of Edo, the two sects of Shingon (222, or 30.1%) and Sodo (210, or 28.5%) occupied just under two thirds of the total number of temples, and that the numbers for the Jodo and Hokke sects were relatively small considering their massive presence in Edo. The number of temples classified as head temples was approximately 10% of the total number in Edo. Most of these were established before Tokugawa Ieyasu's arrival (Nitto 1998). According to the *Gofunai-bikou-zokuhen* which shows the distribution of temples by number as recorded, 172 of the total of 971 temples were located in the district of Asakusa, and approximately one quarter of the temples were concentrated in this district if the calculation includes the 57 temples in the district of Shitaya. The other districts of densely packed temples were Yanaka, Shiba, and Atagoshita. These districts were located in the direction of the demon's gate and the rear demon's gate.

Researcher Masao Suzuki (1988, 2000) clarified the process of the urban construction of Edo based on historical evidence and his own thorough field surveys compiled over a long period. This chapter will examine the distribution of temples and the transit of *teramachi* in Edo based on the results of his research and the histories of each district. In this chapter, *teramachi* means "densely located temple area."

Within the city of Edo (the area around present-day Chiyoda Word and Chuo Word), before Tokugawa Ieyasu, there were 65 temples, as confirmed by historical materials such as the *Gofunai-bikou* and the *Bunsei-jisya-kakiage*. About half of these were established during the period of Ota Dokan, with the other half established during the period of the Hojyo clan (Suzuki 2000). The number of temples increased tremendously after Tokugawa Ieyasu's arrival in Edo. In the area of present-day Chiyoda ward, in which Suzuki conducted an exhaustive survey, the locations of 143 temples were confirmed (32 in Hirakawa District, 73 in Kanda District, and 38 in Kojimachi District). The main reasons for the placement of these temples are as follows: (1) those temples were relocated to Edo together with Tokugawa's vassals from the old territory of the Tokugawa family; (2) *Daimyo* (feudal lords) established temples and graveyards in Edo as proof of their fealty to the Tokugawa family; and (3) temples were established as burial places for common people.

These may be attributed to various factors. For example, the population of Edo increased for several reasons. Many *Daimyo* and their vassals lived in Edo; many common people moved to Edo in addition to Tokugawa's vassals; the number of temples increased commensurately; the *Danka* system diffused; there was competition among religious sects; and there were vast unused areas (Minato Ward Office 1960).

The number of these temples increased concomitantly with the increase in population. Later, many of these temples were forcibly relocated amidst the expansion of Edo and its urban policy.

Suzuki (2000) discussed the period of existence of temples located in present-day Chiyoda Ward. A total of 44 temples existed in the district of Hirakawa, near the Imperial Palace, before Tokugawa Ieyasu's arrival in Edo. Later, these temples were relocated to other districts, along with the deployment of *Tenka bushin* (construction order by the Tokugawa shogunate). With the increase in population after Tokugawa Ieyasu entered Edo, 32 temples were established. However, most of these temples were relocated to other districts at the second *Tenka bushin* in 1613 (Keicho 18), due to the construction of the outer moat of Edo Castle and Daimyo-koji Avenue. In the district of Kanda, 90% of the temples were established after Tokugawa Ieyasu entered Edo. About half of them were relocated to the suburbs, particularly the district of Yanaka, in 1648 (Keian 1). The remaining temples were relocated to the districts of Asakusa, Shitaya, and Komagome and other places after the Great Fire of Meireki in 1657 (Meireki 3). The district of Kanda was then changed to a residential district. The district of Kojimachi, a typical uptown residential area, had a smaller number of temples than that of other districts. Most of the temples in this district were relocated to surrounding outer compound areas, such as Yotsuya and Ichigaya, at the time of the Fourth *Tenka bushin* (in 1622, Kan'ei 5) and the construction of the Nishinomaru-shimo area and stone walls, which faced the outer moat of the eastern section of Edo Castle.

In this way, the establishment of temples was promoted positively in the early Edo period, and the number of temples increased dramatically. However, the shogunate issued the *Jiin-hatto* in 1615 (Genna 1) and repeatedly thereafter to set a limit on the establishment of temples. They did this for several reasons: (1) the area of temples was a factor preventing the further expansion of Edo's urban area; (2) there was increasing demand for sites for samurai residences due to the establishment of the *Sankin-kotai* system (alternate attendance by a *Daimyo* in Edo), through the enactment and revisions of the *Buke Shohatto* (code for warrior households); (3) after the Great Fire of Meirekei, urban planning relocated the temples to places removed from the center of Edo and protected against disasters. In association with the development of Edo's urban area, the relocation of temples was mainly ordered by the shogunate and frequently targeted temples located in the low-lying part of Edo. According to the "History of Chuo Ward," business taxes were charged on the district of Jo-to (east of the Castle) for the construction of *funairi-bori* (inlets used for water transport) in Edo. Thence, this area of temples was allocated to the districts of North Kanda *teramachi* and Hatchobori, and these districts became the area of *teramachi*. However, prior to the construction of the outmost enclosure of Edo Castle, all of the temples in the district of Kyobashi-Hatchobori were forced to relocate to the districts of Shiba or Asakusa in 1635 (Kan'ei 12). Subsequently, many temples were relocated to the districts of Asakusa, Shitaya, Fukagawa, Shiba, and Mita, due to the expansion and congestion of the urban areas. Many temples were established in a focused manner in the district of present-day Chuo Ward, during an approximately thirty-year period from the Keicho to Kan'ei, and then relocated to the suburbs (Chuo Ward Office 1958).

It may be concluded that the outermost works of Edo Castle were constructed through the multiple stages of *Tenka bushin* in the early seventeenth century, and that procuring of the sites for expansion was promoted through the relocation to other areas of the temples in the Castle's vicinity, accompanied by increasing demand for areas the samurai and common people could use.

In many cases, the relocation of temples was forced by the shogunate by way of public confiscation. The sites of many temples were confiscated to provide samurai land, and alternative sites were provided. Many temples were then forced to relocate to the suburbs (Nishiyama 1983). After the Great Fire of Meireki (1657), many more temples were forced to relocate from their original locations around the Castle to prevent disasters: temples with large wooden roofs were so flammable that they had to be relocated to prevent fires from spreading to the Castle. Without exception, many prominent temples were also targets of this relocation effort: Some examples are Nishi Hongwan-ji Temple (from Yokoyama-cho, Nihonbashi to Tsukiji), Reigan-ji Temple (from Reiganjima to Fukagawa), and Higashi Hongwan-ji Temple (from Kanda-myojinshita to Asakusa). Through the above urban policies, the relocation sites of the temples moved from the city center formed new *teramachi*. Some examples of these include Asakusa, Shitaya, Ushigome, Yotsuya, Akasaka, Shiba, and Mita (Tamura 1992).

Temples were forced to relocate frequently under the administration and control of the shogunate, particularly in the early Edo period. Research reveals that a similar tendency of relocation was applied to shrines, which tended to be more linked with a specific site (location environment) than temples.

According to Shinoda et al. (2004), most shrines were established naturally at a site with good topographical conditions near villages or roads, or in a lowland area at the water's edge. However, after the *Tenka busin* began, the policy of relocation to outside the Castle's walls was also applied to the shrines. Unlike the temples, the relocation sites for shrines had good topographical conditions, taking into account the natural surroundings of their original location. However, after the Great Fire of Meireki, the number of shrines forcibly relocated to make way for public use (i.e., space provided as a firebreak or as a samurai residence) increased. In particular, the sites of shrines located on hills or the tip ends were targets for samurai suburban residences. Accordingly, the relocation sites for such shrines were also fixed by the shogunate as spaces under its control.

In conjunction with the urban spread, the locations of religious facilities continued to change, demonstrating the shogunate's political supremacy over religious authority.

It may be a characteristic of Edo as a religious city that the shogunate placed temples under its control and integrated them into its political mechanism, including relegating the religious worldview to the bottom of the urban structure.

6.4 Religion as a Leisure Space

6.4.1 Land Use for Rent and Entertainment in the Precinct of Temples and Shrines

As considered in the previous section, in the seventeenth century, many temples were founded and relocated as the establishment of the shogunate progressed; Edo experienced a rapid expansion of its urban area and an extension to its outer area.

Table 6.1 Changes on temples and shrines in Edo from Nishiyama 1983 (Matsui 2014)

	Number of new Temple towns	Number of Temples having rental land	Number of temples having rental house
~1599	–	–	–
1600~1609	–	–	–
1610~1619	–	–	–
1620~1629	31	–	–
1630~1639	25	–	–
1640~1649	38	–	–
1650~1659	31	–	–
1660~1669	24	–	–
1670~1679	6	–	–
1680~1689	14	–	–
1690~1699	12	–	–
1700~1709	15	–	–
1710~1719	3	20	–
1720~1729	2	34	–
1730~1739	13	36	26
1740~1749	9	44	26
1750~1759	8	46	24
1760~1769	4	37	49
1770~1779	3	41	50
1780~1789	6	35	47
1790~1799	1	33	35
1800~1809	–	30	30
1810~1819	–	35	36
1820~	–	38	31

From Nishiyama (1983)

The establishment and relocation of temples generally concluded during the Houei era in the early eighteenth century (Nishiyama 1983). Table 6.1 shows movement of the sites of temples and shrines from the sixteenth century to the early seventeenth century, which was outlined by Nishiyama. We note that the temples and shrines formed *Monzen-machi* (temple towns) in their precincts by renting space and building houses for rent by common people. In the era of Genroku at the end of the seventeenth century, the shogunate ordered a prohibition against offering any land or houses for rent within the precincts of temples or shrines to the residents of *Monzen-machi*. However, as the development of urban infrastructure could not meet the increasing market demand of Edo's rapidly expanding urban area, temples and shrines started renting their land and houses. Subsequently, *Monzen-machi* of a new style developed as *Machiya* (town houses). According to Nishiyama, the new *Machiya* of Edo had a unique social organization, in which temples and shrines rented their land to the residents of *Machiya* and made them run commercial businesses. This phenomenon was not found generally in Kyoto and Osaka (Ito 1995).

The new *Machiya* of Edo had two purposes, namely the improvement of the urban area and the management of temples or shrines. It is understood that Edo's temples and shrines were characterized by the above-mentioned *Monzen-machiya* (*Machiya* built on land within the precinct of a temple or shrine).

In the early seventeenth century, when the new *Monzen-machi* emerged, their featured wayside teahouses and souvenir shops. However, as the areas owned by temples were privileged spaces and not accessible to the magistrate's office, the number of facilities of unlicensed prostitutes, such as teahouses and whorehouses (*okabasho*), increased. Thus, *Monzen-machi* developed as entertainment districts. As Edo was a male-oriented society, a rapid expansion occurred in the space of the amusement and entertainment districts. The most prosperous *Monzen-machi* included those located in front of large temples, such as the Ikenohata of Ueno-Kan'ei-ji Temple; those located in front of Shinmei gate of Zojo-ji Temple in Shiba and Otowa gate of Gokoku-ji Temple; and those of Senso-ji Temple and Tomioka Hachimangu Shrine. The shogunate considered it impossible to keep control over these new *Monzen-machi*. During the era of Enkyo in mid-eighteenth century, the shogunate issued laws and ordinances changing the *Monzen-machi* area of temples (440,000 m^2) and 227 sites within the precincts of temples and shrines into spaces usable for Edo's residents. It is thought that temples and shrines began to openly engage in running profit-making businesses, such as renting out land and, subsequently, houses, in this period (Nishiyama 1983). Kaneyuki (2000) showed the status of land owned by *Monzen-machiya*. Kyozen-ji Temple, Azabu owned a precinct of approximately 3300 m^2. An average-sized temple, it owned 22 houses, of which half (11) were used by house owners and some were for rent. The owner leased the land from the landlord and could use his/her houses to generate rent. It is assumed that some of these houses were rented by highly mobile petty people (Kaneyuki 2000). The inner depth of this *Monzen-machiya* was shallow and featured a landscape typical of this sized *Monzen-machiya* of temples or shrines. The precincts of temples and shrines prospered as spaces for the performance of various forms of public entertainment, including shows. Performances held in temple and shrine precincts were called *Miyaji-shibai* (farces) or *Ko-shibai*. They were permitted as special events, so the period of these performances was limited to 100 days (although this could be extended). It is understood that the precincts of Kanda Myojin Shrine, Shiba-shinmei Shrine, Yushima-tenjin Shrine, and Ichigaya-tenjin Shrine prospered as performance spaces (Nishiyama et al. 1984). The background for this development was the emergence of land and houses for rent in the area of temples and shrines.

This phenomenon was not limited to Edo. Yamachika (1991) examined the entertainment performances held in the precincts of temples and shrines in Kyoto during the late early-modern period. He observed that various facilities, including land for rent, existed in such precincts in Kyoto and that, in the case of a temple or shrine renting out part of their precinct to common people, the commoners usually built some facilities there. In this case, in addition to dwellings and houses for rent, simple facilities for business use without a residential function, called *hi-goya*, were built. In these facilities, performances of various kinds, such as plays, were held. Additionally, there were restaurants and other shops. This phenomenon also appeared at the *Monzen-machi* in Nagoya (Osu-kannon Temple), among other places.

It can be understood from the above that the demand for use of temple and shrine areas increased due to chronic shortages in usable land, in conjunction with the rapid expansion of the urban area; moreover, because of economic considerations regarding the business maintenance of temples and shrines, the land use of these precincts changed as land and houses were made available for renting to common people. Temple and shrine areas became unusual energetic gathering spaces, attracting wandering entertainers. They had the power to attract large numbers of people in their guise as amusement districts, and, thus, provided suitable spaces for leisure.

6.4.2 Landscapes of Temples and Shrines as Famous Places

In their function as leisure spaces, temples and shrines were accorded an aesthetic value as famous places of Edo. This section will examine the characteristics of the landscapes of temples and shrines as famous spots, based on landscape scholarship in the fields of architectonics and landscape architecture. Hanyu and Okano (2003) extracted spots considered famous from the Edo period as listed in guidebooks published from the Edo period to the post-war era of the Showa. They identified them as "Traditional Famous Spots," and then examined how their description changed after the Meiji period.

They examined five guidebooks: *Edo Meisho-ki*, *Edo Suzume*, *Edo Canoko*, *Edo Sunago* and *Edo Meisho-zue*. Hanyu and Okano (2003) shows the common characteristics extracted from this study. Most of the spots appearing in all five books are temples or shrines; others are waterfronts, such as the *mitsumata* (three-forked rivers) close to Nihonbashi and the Shinobazu Pond.

Most of these temples and shrines were connected to the Tokugawa family, such as Zojyo-ji Temple, Dentsu-in Temple, Kan'ei-ji Temple, Senso-ji Temple, Hie-sanno Shrine, and Kanda Myojin Shine. It is understood that these temples and shrines owned vast tracts of land and were places of performance and entertainment, which formed *Monzen-machi*. Among the five guidebooks, the *Edo meisho-zue* (published in 1836, Tenpou 7) is the most thorough regarding the number of listed places and plenitude of contents. According to this guidebook, there were diverse kinds and quantities of annual events and physical components in the temples and shrines, as listed under "Type of Precinct" and under "Type of Suburbs," the latter of which details their place in the suburbs of Edo. It is understood that these temples and shrines had a variety of attractions; many of those belonging to the above types survived as famous spots beyond the Meiji period (Hanyu 2005). It is noted that most of the area owned by Kan'ei-ji Temple and Senso-ji Temple underwent a drastic change after the Meiji period by transforming themselves into city parks. For the common people, famous spots were not limited to those temples and shrines with long and distinguished histories and those located in beautiful areas, with a good environment and beautiful scenery. In the eighteenth century, many trees, such as cherry and peach, were planted in spots located in Edo's suburbs, such as Sumida-zutsumi, Nakano, Koganei, and Ouji (Asukayama). These became recreation areas for activities enjoyed by common people in many ways, such as worshipping at temples and shrines, eating and drinking, and strolling around. Many vacationers visited these places in the late Edo period. According to Ono (1987)'s analysis of the inspiration for creating the famous spot of Asukayama, this area was originally a religiously important place, which turned into a famous cherry-blossom viewing (*hanami*) spot thanks to the maintenance of its infrastructure promoted by Tokugawa Yoshimune, the eighth shogun. In the latter part of the Edo period, many pleasure resorts formed in Edo's suburbs. Vacationers visited year-round, not only during the tourist seasons. The amusements for vacationers involved worshipping at temples and shrines, merrymaking at restaurants, and strolling through the suburbs (Ono 1983). For example, in older times, Mukoujima was in a farming area in Edo's suburbs; however, by the end of the eighteenth century, it had become known as a place of high-class restaurants, as well as an outlying place of performances by geishas. In these Edo suburbs, farmers cultivated flowers and plants as side-businesses on an extensive scale. The gardens of the temples and shrines were also destinations for vacationers. In the vast precinct of Akiba-Gongen, where "fountains were located skillfully, mountains were constructed along a north street, and a variety of trees were planted in rows," vacationers could enjoy seeing Japanese apricots, warblers, the shooting buds of many trees, irises, cuckoos, Satsuki azaleas, bush clover, and colorful autumn leaves. Just like Akiba-Gongen, the natural beauty surrounding the Kan'ei-ji Temple in Ueno could be enjoyed throughout the year. This spot also attracted visitors with its gardens and scenic landscapes (see Fig. 6.6). Along with the expansion in scope of tourist resorts, restaurants proliferated, with rows of them lining the gates in front of famous temples and shrines (see Fig. 6.7). In the latter part of the eighteenth century, outdoor amusement had become an everyday affair. One of the main leisure activities for common people was the act of visiting a shrine or temple in the suburbs and being entertained at a restaurant (Ono 1983). Kishimojin (the goddess of children) in Zosigaya, Myoho-ji Temple in Horinouchi, Meguro Fudo Temple, Kameido Temmangu Shrine, and Tomioka Hachimangu Shrine in Fukagawa were spots located 5–10 km away from the center of Edo, all accessible in a day trip. They were attractive spots for vacationers, particularly on festival days or on days of unveiling a treasured Buddhist image, when crowds gathered at the related temple or shrine. Events performed at temples and shrines tended towards those of amusement (see Fig. 6.8). This act of worshiping at individual temples and shrines prospered in combination with the form of worship by pilgrimage to multiple temples and shrines, successively (*Senjya-mairi* and *Fudasho-mairi*, respectively). The destinations for worship were not only the temples and shrines in Edo's suburbs but also, in many cases, those located far away. In the eighteenth century, many *Ko* (confraternities) were established throughout the Kanto region for the purpose of worshiping at famous temples and shrines located far from Edo, which required sleeping accommodation. These faraway temples and shrines included, for example, Mt. Fuji, Mt. Sagami-Oyama, Mt. Haruna, and Narita-san Shinsho-ji Temple. For commoners at that time, there

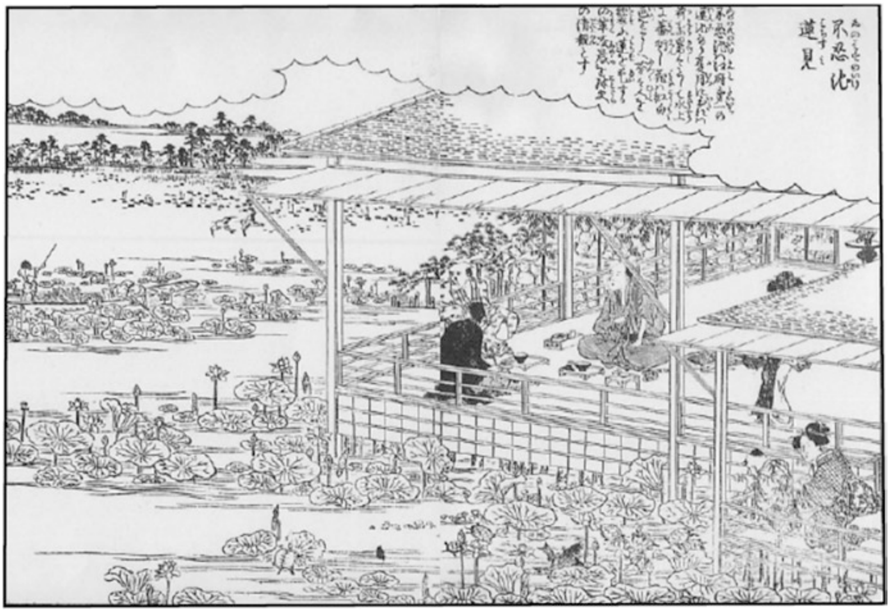


Fig. 6.6 Lotus flower viewing at Kaneiji-temple from "Edo Meisho Zue Vol.5" (Ichiko and Suzuki 1996)

Fig. 6.7 Enjoying a meal at Tomioka-hachiman Shrine in winter from "Edo Meisho Zue Vol.7" (Ichiko and Suzuki 1996)

Fig. 6.8 Buddhist memorial service at Kishimojintemple in Zoshigaya from "Edo Meisho Zue Vol.4" (Ichiko and Suzuki 1996)

were many restrictions on traveling alone beyond their residences. Therefore, a pilgrimage with a confraternity became a fundamental way of travelling. Visiting temples and shrines was a form of sightseeing that included visiting noted places of historic interest, finding opportunities to obtain the latest agricultural knowledge, and getting in touch with the world (Matsui, 2013). In particular, Ise Shrine was incorporated into the leisure plans of Edo's common people as a spot to visit at least once in a lifetime (Onodera, 2005). The main pilgrimage route from the Kanto region to Ise Shrine was via the Tokaido on the outward leg of the journey and the Nakasendo highway on the homeward stage.

It was not unusual to make the following grand tour. It would begin by travelling south from Ise Shrine to Kii Peninsula, visiting Seiganto-ji Temple as the first *fudasho* (temple where amulets were distributed to pilgrims), and then seeing the other temples of the 33 Saigoku Kannon Pilgrimage. One would then cross the Inland Sea by ship to the Shikoku region, visiting the Konpira-jinja Shrines and Mt. Tanigumi as the last installment of the 33 Saigoku Kannon Pilgrimage, before finally visiting Zenko-ji Temple down the Nakasendo highway and returning to the Kanto region (Onodera, 2002). As an alternative to visiting faraway temples and shrines, in some cases, worship could be carried out by the act of *Bunrei* (transferring the separated spirit to a new shrine) or *Kanjin* (dividing a shrine's tutelary deity and enshrining it in another shrine) by building a monument (mound or imitation mount).

Further, pilgrimages were made to *utsushi-reijo* (imitations of sacred places) of temples and shrines in the Shikoku region and of the Saigoku Kannon Pilgrimage. Moreover, visits were made to *Fuji-zuka* mounds for the worship of Mt. Fuji from afar. These were also leisure activities for common people (Kondo 1995; Kawai 2001; Miki 2001).

As described here, leisure activities included not only those performed in daily cycles but also in a monthly or yearly cycle, or even as rarely as once in a lifetime; thus, there existed sightseeing activities solely for the purpose of worshiping, as well as sightseeing associated with visiting temples and shrines. For Edo's common people, conduct of religious and leisure activities were intertwined through worshiping at temples and shrines.

6.5 Conclusion

This chapter has outlined the distribution, landscape, and functions of temples and shrines in the city of Edo, and evaluated the urban structures whose construction was based on magico-religious space design.

This study produced five key findings.

1. A city design modeled on *Heian-kyo* was applied to the construction of the city of Edo, based on the proper arrangement of the gods of the four directions. This model was intended to protect the city of Edo not only militarily but also in magical and religious ways. In particular, large temples and shrines related to the Tokugawa shogunate family were placed in the directions of the northeast and southwest, which were regarded as unlucky and were places of execution where the red-light districts also formed in areas bordering the city. This arrangement created extraordinary atmospheres in the city. Tokugawa Ieyasu was awarded the posthumous holy name (literally, a Shinto deity title) Tosho-daigongen and enshrined in the position of the North Star (Nikko) to protect the city of Edo. The application of such magical factors to the protection and safeguarding of the city is one of the characteristics of Edo.
2. Temples and shrines were under the control of the Tokugawa shogunate during the Edo Period, and the *Honmatsu-seido* (government-enforced main-branch temple system) was established through the enactment of *Jiin-hatto*. Furthermore, the public was forcibly linked to temples and shrines with the status of *danka,* introduced under the *Terauke-seido*. Through this compulsory administration of religion, temples were integrated into the maintenance system of the social order, serving a marginal role in the mechanism of the Tokugawa shogunate.
3. The temple and shrine estates were almost the same size as the townsperson estates, and occupied a large part of the city of Edo in terms of land use. Shrines rapidly proliferated along with the city's population. Consequently, control measures were introduced to restrict the establishment of temples in the city's central areas, where land supply shortages were caused by high demand, and temples

were moved to the suburbs almost forcibly. This tendency became more evident in the planning of the city after the Great Fire of Meireki in 1657; subsequently, new towns of temples were created in districts such as Asakusa, Shitata, and Mita.
4. The rapid expansion of urban areas in the city of Edo caused the religious facilities to utilize their space for leasing land and renting houses. Consequently, new *Monzen-machi* were created in the precincts of large temples; some of these towns developed into amusement districts, as places for theatrical and dramatic performances.
5. Most of the famous and scenic places in the city of Edo were temples and shrines. In particular, temples with spacious precincts and those located in the suburbs developed into leisure places that the public visited to worship and, more generally, to enjoy eating, drinking, and strolling, in addition to visiting on festival days and for annual events. In particular, temples and shrines located within 5–10 km of the city center were popular resorts and destinations for day trips, sightseeing, and pleasure seeking. Furthermore, famous temples and shrines located far away from Edo attracted many pilgrims. Some temples and shrines located 50 to 100 km away established organizations called *ko-sha*, which targeted tourists needing accommodation. Pilgrimages to visit temples and shrines was a typical way of travelling at that time.

These characteristics of Edo as a religious space were strongly affected following the Meiji Restoration. There were many intense changes in the religious environment, such as the lifting of the ban on Christianity, the abolition of the *Terauke-seido*, the introduction of *Haibutsu-kishaku* (a movement to abolish Buddhism), significant reductions in and changes to urban parks in temple and shrine precincts, and the establishment of the Yasukuni Shrine and the Meiji-jingu Shrine. In such circumstances, the structure of Edo as a religious space inevitably changed.

There are many other matters that could be addressed in this chapter. However, due to its limited scope, the author was unable to examine these issues further. Thus, these matters should be explored in future studies.

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Chapter 7
History of Urban Water Use in Tokyo with Focusing on Surface and Subsurface Water as Water Sources

Akio Yamashita

Abstract The purpose of this study is to organize the history of urban water use in Tokyo with focusing on two water sources: surface water and groundwater. The urban water supply-demand space in Tokyo shifted from a three-dimensional structure, including underground space, to wide-spread and two-dimensional one, excluding underground space. To foster sustainable urban water supply systems, efforts are needed to both avoid an increase in water demand and maintain local groundwater resources. Moreover, in terms of water security, at the time of disaster or water shortage, sustainable urban water supply systems should include both large-scale extensive water supply systems and locally distributed water supply systems to supplement each other.

Keywords Urban water use · Surface water · Groundwater · Public waterworks

7.1 Introduction

The water resource policy objective for Japanese major cities, such as Tokyo, was the development of infrastructure for new water sources, in order to accommodate increased water demand. Recently, the objective has changed to the restructuring of existing water sources, aiming to address a decrease in or stagnation of water demand. In reality, Japan's total industrial water demand has decreased since the 1970s (Togashi 2011), and even the residential water demand started to decrease in the 1990s (Yajima 2011). The recent concern regarding water resources centers around flexible water transfer in emergency situations, such as water shortages and natural disasters (Yamashita 2009a).

Although transferring water rights from agricultural to residential has been discussed as a possible method to introduce flexible water use (Akiyama 1980; Hara

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1984), it should be noted that groundwater is viewed as another possible alternative water source. Conventional water resources development enhanced the dependency on "distant water," i.e., dams constructed in mountainous regions, instead of "close water," such as wells and nearby rivers (Moritaki 2003). However, the necessity of river policies on countermeasures against flooding and water shortages, without depending upon dams in future (Ito 2011), requires focus on groundwater (Togashi 2011) as a typical "close water."

Traditionally, groundwater has been considered "private water" and has been eschewed by public urban residential water supply systems (Masuda 2011). Moreover, urban water demand sources were historically switched from groundwater to surface water because over-pumping of groundwater caused critical land subsidence problems in Japan's metropolitan areas. Recently, however, the rise of groundwater levels due to the restriction of groundwater withdrawal induced a new problem that urban subsurface structures are damaged by groundwater pressure (Shimizu 2007; Tokunaga 2007). Therefore, groundwater must be used properly while maintaining sufficient recharge levels through continual monitoring (Hayashi et al. 2009) and the integrated water management of both surface and subsurface water (Hiroki 2010).

In the field of human geography, Moritaki (1982) and Shirai (1987) conducted studies on urban water resources problems. Moritaki (1982) discussed the environmental and social problems caused by water resources development, while Shirai (1987) discussed river water use coordination between new water resources development and existing water rights. Akiyama (1988) reviewed these studies from a post-World War II perspective, as regards the reorganization of the traditional water use order. In Japan, geographers have led water policy studies (Noda 2012), with the subject continuing to be a source of discussion today. However, regarding the topic of a permeable border between surface and subsurface water, Taniguchi (2010) publicized concern that this remains a low priority in the field of human and social sciences. While human geographical studies have mainly focused on surface water development, groundwater has not been adequately addressed.

The purpose of this study is to organize the history of urban water use in Tokyo with focusing on two water sources: surface water and groundwater. Firstly, the following four matters are chronologically organized: (1) the expansion of metropolitan waterworks; (2) the enhancement of surface water resources; (3) the progress of land subsidence; and (4) groundwater pumping. Secondly, the case cities demonstrate the changes in groundwater use and the current conservation policies. Finally, this study discusses the sustainable urban water supply-demand system.

7.2 The Change of Metropolitan Waterworks in Tokyo

7.2.1 Origin of Modern Waterworks and Its Expansion

Tokyo's original water supply system, named "Koishikawa-Josui" (or "Kanda-Josui), was implemented in 1590, using the Inokashira Pond (in Mitaka and Musashino Cities today) as a water source. During the Edo era (1603–1868), other canals were constructed to create an urban water supply system. These included the Tamagawa-Josui drawing from the Tama River (Hamura intake weir in Hamura City today) in 1654, Kameari-Josui (or Honjo-Josui) from the Hurutone River in 1659, and three branches of Tamagawa-Josui (Aoyama-Josui in 1660, Mita-Josui in 1664, and Senkawa-Josui in 1696). While these six canals were formerly known as the "major six canals in Edo," four of the six were abolished in 1722, and Edo's water supply system was integrated into the Kanda-Josui and Tamagawa-Josui systems.

In the Meiji era (1868–1912), waterworks with modern technologies were established in 1898. The water source was the Tama River, and its water conduits were based on those of Tamagawa-Josui in the Edo era.

The history of the expansion of Tokyo's modern metropolitan waterworks is chronicled in Table 7.1, while the location of major water sources is indicated in Fig. 7.1. While the metropolitan waterworks originally sourced its water from the Tama River, with the construction of the Murayama Reservoirs in Higashiyamato City and the Yamaguchi Reservoir in Tokorozawa and Iruma Cities, Saitama Prefecture, it has been drawing water from the Edo River since 1936. As of 1945, the metropolitan waterworks had a water supply capacity of 879,000 m^3 per day. As of 1939, its coverage reached 88.7% of the population.

The post-World War II expansion projects of Tokyo's metropolitan waterworks were accompanied by a sharp increase in water demand to meet Tokyo's rapid urbanization and population inflow. Ogochi Dam on the Tama River, which was under construction during the war, was completed in 1957. In the same year, the Tokyo Metropolitan Government built the Nagasawa Water Treatment Plant in Kawasaki City, Kanagawa Prefecture to take water from the Sagami Dam on the Sagami River. Moreover, the amount of water intake from the Edo and Naka Rivers greatly increased in the 1960s. Consequently, more than eight million people were being supplied with this water in 1965, which was more than double the water supplied population in 1950 (Bureau of Waterworks, Tokyo Metropolitan Government 1999).

7.2.2 Integration of Municipal Waterworks in the Tama Region

In the 1960s, the water supply area of the metropolitan waterworks was mostly limited to the 23 wards. Conversely, in the area outside these wards, i.e., the Tama Region, each municipality operated individual waterworks, mainly sourced by groundwater. With the rapid increase in water demand due to urbanization and

Table 7.1 History of the expansion of Tokyo's metropolitan waterworks (Yamashita 2013)

Year	Event	Water source	Capacity (thousand m^3/day)	
			Icrease or decrease	Total
1898	Completion of Yodobashi Water Treatment Plant	Tama River	167	167
1911	Expansion of Yodobashi Water Treatment Plant	Tama River	73	240
1924	Construction of Murayama-kami Reservoir	Tama River	140	380
1928	Construction of Murayama-shimo Reservoir	Tama River	40	420
1932	Integration of small community waterworks	Tama and Edo Rivers, groundwater	186	606
1934	Construction of Yamaguchi Reservoir	Tama River	56	662
1935	Merger of Tamagawa water supply company	Tama River	104	766
1936	Development of water intake from the Edo River	Edo River	90	856
1937	Merger of Yaguchi water supply company	Groundwater	3	859
1945	Merger of Nihon water supply company	Tama River	14	873
1938–45	Expansion work of water distribution facilities	Groundwater	6	879
1946	Cessation of Yoyohata and Yaguchi water sources	Groundwater	−14	865
	Improvement of Sakai Water Treatment Plant	Tama River	75	940
1936–53	Emergency development work of additional water sources	Tama and Edo Rivers, groundwater	282	1,222
1957	Completion of Ogochi Dam	Ogochi Dam	425	1,647
1950–59	Waterworks expansion work in the Sagami River Basin	Sagami Dam	200	1,847
1959	Improvement of Tamagawa, Kinuta-kami and Kinuta-shimo Water Treatment Plants	Tama River	104	1,951
1960–64	Development of water intake from the Edo River	Edo River	95	2,046
1962–65	Emergency development of water intake from the Naka and Edo Rivers	Naka River	400	2,446
1963–68	First waterworks expansion work in the Tone River Basin	First full plan	1,200	3,646
1969	Abolition of Komae water source	Tama River	−14	3,632
1965–70	Second waterworks expansion work in the Tone River Basin	First full plan	1,400	5,032
1970	Cessation of Tamagawa Water Treatment Plant	Tama River	−152	4,880
1970–76	Third waterworks expansion work in the Tone River Basin	Second full plan	1,200	6,080

(continued)

Table 7.1 (continued)

Year	Event	Water source	Capacity (thousand m³/day)	
			Icrease or decrease	Total
1972–85	Fourth waterworks expansion work in the Tone River Basin	Third full plan	550	6,630
1991	Improvement of Misato Water Treatment Plant	Third full plan	275	6,905
	Shrinkage of Kanamachi Water Treatment Plant	Edo and Naka rivers	−220	6,685
1993	Improvement of Misato Water Treatment Plant	Third full plan	275	6,960
2004	Shrinkage of Kanamachi Water Treatment Plant	Edo and Naka rivers	−100	6,860

Sources: data and materials from Bureau of Waterworks, Tokyo Metropolitan Government

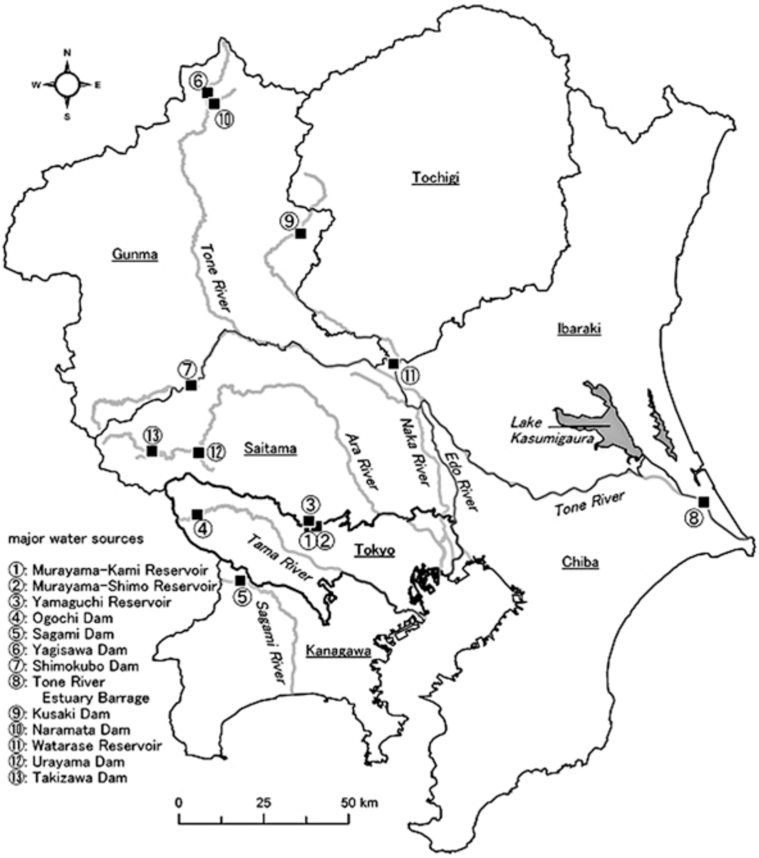

Fig. 7.1 Major water sources of Tokyo's metropolitan waterworks (2011) (Sources: data and materials from Bureau of Waterworks, Tokyo Metropolitan Government)

population increase, the individual waterworks in the Tama Region proved insufficient in their capacities to meet water demands. In 1971, the Tokyo Metropolitan Government developed a master plan calling for the integration of individual municipal waterworks in the Tama Region into the metropolitan waterworks. Based on this plan, the municipal waterworks in Kodaira, Komae, Higashiyamato, and Musashimurayama Cities were integrated in 1973, with another 24 municipalities also integrated by 1977. The Tachikawa, Chofu and Mitaka City waterworks were also integrated in 1982, 2000, and 2002, respectively (Fig. 7.2). From this integration, residential water from the metropolitan waterworks, largely sourced by surface water, began being distributed to much of the Tama Region. Conversely, Musashino, Akishima, and Hamura Cities, and Hinohara Village have continued to operate individual municipal waterworks.

7.2.3 Capacity Expansion and Water Source Enhancement Through the National Master Plan for Water Resources Development in the Tone River Basin

Tokyo's long-standing wish to intake its water from the Tone River, one of the largest rivers in Japan (Bureau of Waterworks, Tokyo Metropolitan Government 1999) would finally be realized. In 1961, two national laws on water resources development were enacted: the Water Resources Development Promotion Law and the Water Resources Development Corporation Law. According to these laws, the national government would promote water resources development in six major Japanese river basins, including the Tone River Basin.

The national government formulated "A Master Plan for Water Resources Development in the Tone River Basin," which is commonly referred to as the first full plan. The Tokyo Metropolitan Government decided to implement its first waterworks expansion in the Tone River Basin, relying on the water sources developed by the first full plan. However, the national water resources development did not proceed as scheduled. Hence, the full plan was modified in 1970 (the second full plan), and then amended to include the Ara River Basin in 1976 (the third full plan). Finally, the fourth full plan was instituted in 1988. Therefore, the Tokyo Metropolitan Government was forced to modify its waterworks expansion in the Tone River Basin several times (Table 7.1).

Focusing on Tokyo's metropolitan waterworks, Table 7.2 shows the chronological process of water source enhancement after the first full plan. Comparing Tables 7.1 and 7.2, it is evident that the Tokyo Metropolitan Government promoted extending the waterworks facility's capacity in advance of ensuring sufficient water sources. This was due to the national full plan not progressing as planned. Since 2008, the waterworks facilities have been operating at a capacity of 6,860,000 m^3 per day (Table 7.1), while the total amount of water available from sources remains at 6,300,000 m^3 per day (Table 7.2).

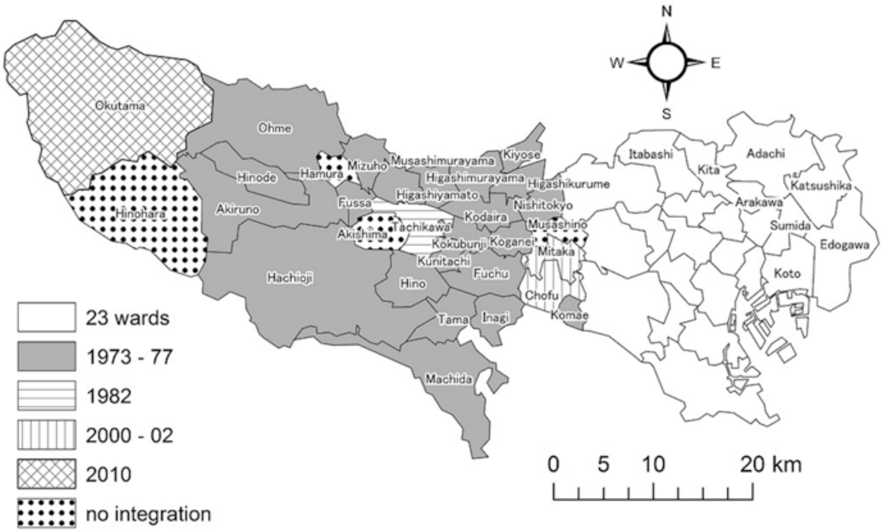

Fig. 7.2 The years of municipal waterworks integration into the metropolitan waterworks in Tama Region (Yamashita 2013) (Sources: data and materials from Bureau of Waterworks, Tokyo Metropolitan Government)

Table 7.2 Enhancement of water sources after the first full plan in the Tone and Ara River Basins (Yamashita 2013)

Year	Water source	Amount of water source (thousand m^3/day)	
		Increase	Total
	Amount of water source before first full plan		2,446
1967	Yagisawa Dam	364	2,810
1968	Shimokubo Dam	1,030	3,840
1971	Tone River Estuary Barrage	710	4,550
1976	Kusaki Dam, Naramata Dam (interim) and Noda Channel	800	5,350
1985	Naramata Dam, Watarase Reservoir and Kasumigaura Channel	620	5,970
1989	Minumadai Canal	50	6,020
1997	Arakawa Retention Reservoir	110	6,130
1999	Urayama Dam	100	6,230
2008	Takizawa Dam	70	6,300

Sources: Data and materials from Bureau of Waterworks, Tokyo Metropolitan Government

In reality, though, the metropolitan waterworks' maximum daily water distribution amounted to 4,900,000 m^3 per day in 2010, and has been decreasing since 1992 (Fig. 7.3). Thus, at present, the current water source is more than adequate.

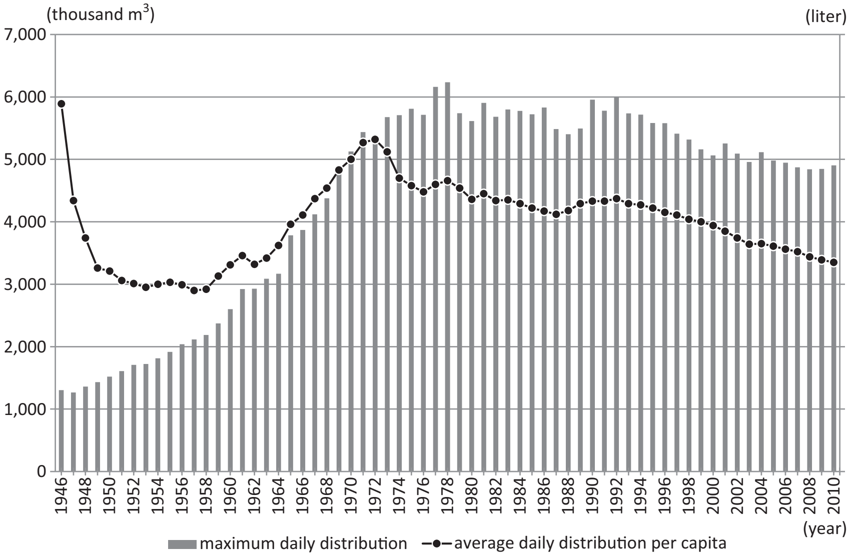

Fig. 7.3 The maximum daily distribution and average daily distribution per capita of the metropolitan waterworks (Yamashita 2013) (Sources: data and materials from Bureau of Waterworks, Tokyo Metropolitan Government)

7.3 Land Subsidence and Groundwater Pumping

7.3.1 Land Subsidence Problem and Control of Groundwater Pumping in Tokyo

According to some reports on land subsidence in Tokyo (e.g., Bureau of Waterworks, Tokyo Metropolitan Government 1986; Bureau of Environment, Tokyo Metropolitan Government 2011; Civil Engineering Center, Tokyo Metropolitan Government (Ed.) 2011), land subsidence in Tokyo began to be observed at the end of the Meiji era, and mainly occurred in the eastern lowland, i.e., Sumida, Koto, and Edogawa Wards. At the beginning of the Showa era (1926–1989), before World War II, land subsidence was recorded at a rate of over 10 cm per year as industrialization resulted in a rapid increase in groundwater withdrawal. During World War II, land subsidence temporarily calmed with the cessation of industrial activities. In the 1950s to 60s, land subsidence accelerated again as industrial activities restarted in the lowland area as part of Japan's high economic growth. Consequently, some places sank more than 400 cm, which cumulatively became known as the "zero-meter area." Even in the Tama Region, land subsidence became evident as groundwater use sharply increased due to rapid urbanization and population growth.

To prevent land subsidence problems due to over-pumping of groundwater, several laws and ordinances were established to limit groundwater use, and industrial waterworks were constructed to provide alternative water sources. The Industrial

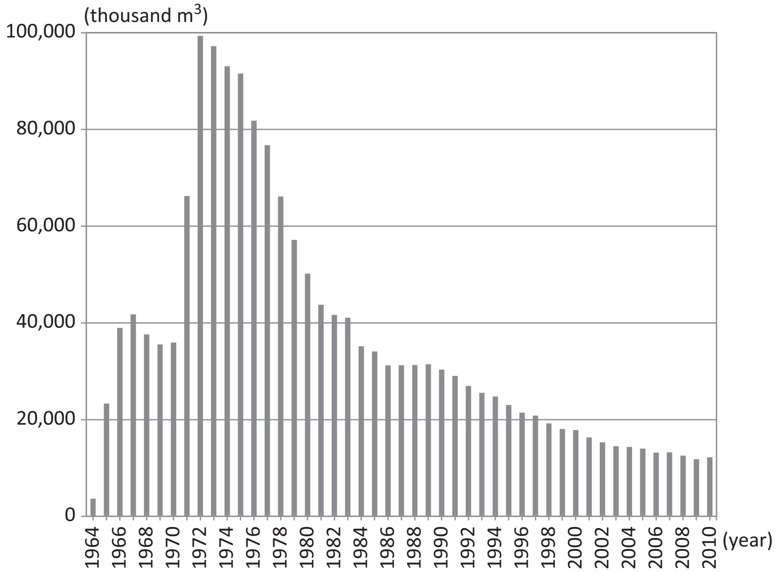

Fig. 7.4 The total annual water supply of industrial waterworks in Tokyo (Yamashita 2013) (Sources: data and materials from Bureau of Waterworks, Tokyo Metropolitan Government)

Water Act and the Building Water Law were enacted in 1956 and 1962, respectively. The Tokyo Metropolitan Government also established the Pollution Control Ordinance and the Environment Preservation Ordinance in 1970 and 2001, respectively. Based on these regulations, groundwater pumping for all purposes has become restricted in almost the whole area of Tokyo, including the Tama Region.

In 1964, Koto Industrial Waterworks, which sourced water from the Mikawashima Wastewater Treatment Plant in Arakawa Ward, started to distribute industrial water to Sumida, Koto, Arakawa, Edogawa, and Adachi Wards. In 1971, Johoku Industrial Waterworks began supplying industrial water to Kita, Katsushika, Itabashi, and Adachi Wards. The Tone River Estuary Barrage was constructed to guarantee a source for operating this waterworks. As indicated in Fig. 7.4, however, the amount of distribution peaked in 1972, just after Johoku Industrial Waterworks became operational, and drastically decreased thereafter due to factory closures and the spread of circulative water use. Accordingly, Koto Industrial Waterworks dismantled a water treatment plant in 1980 and Johoku Industrial Waterworks scaled back its water source from 3.38 m^3/s to 1.57 m^3/s in 1983. Finally, in 1997 the two industrial waterworks merged with Tokyo Industrial Waterworks. Meanwhile, the still operating industrial waterworks has continued to be used for general services since 1973. Today, such general service water constitutes more than 40% of the total amount.

Be that as it may, the groundwater level recovered and land subsidence nearly stopped in the 1970s and 1980s due to the restrictions on groundwater pumping and the construction of industrial waterworks.

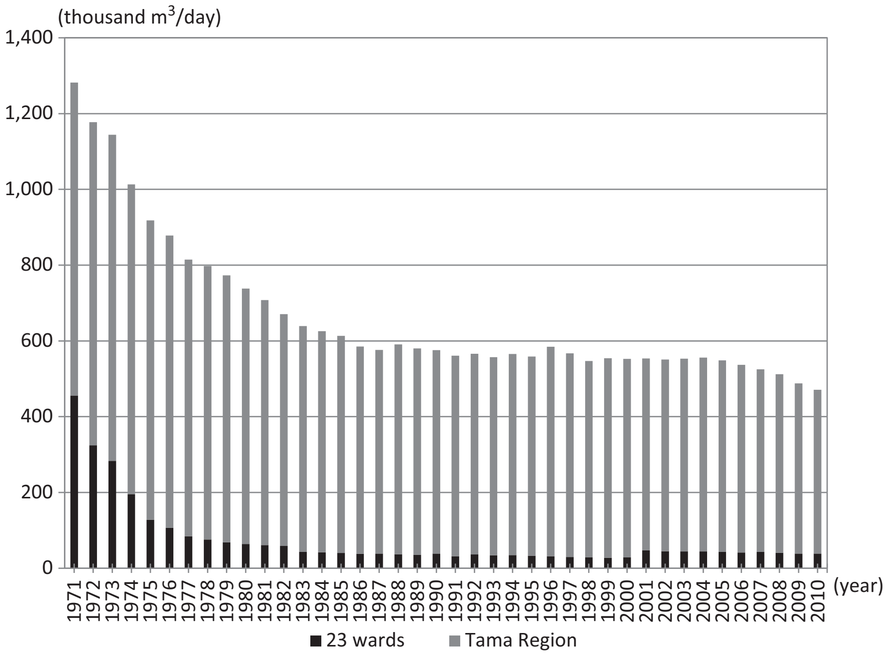

Fig. 7.5 The amount of groundwater pumping in Tokyo (Yamashita 2013) (Sources: data and materials from Bureau of Environment, Tokyo Metropolitan Government)

7.3.2 Transition of the Amount of Groundwater Pumping

Figure 7.5 indicates the transition of the amount of groundwater pumping in Tokyo since 1971. While the pumping amount in 1971 exceeded 1,200,000 m^3 per day, it then rapidly decreased, falling below 600,000 m^3 per day in 1986. Although the diminution rate after 1986 has not been quite as high, the pumping amount continues to decrease every year.

The main use for groundwater in the eastern lower part of the 23 wards is industrial. However, industrial water use had drastically declined there by 1980 due to the previously mentioned restrictions on groundwater pumping and the construction of industrial waterworks. The usages for general service and residential water in the hilly western part of the 23 wards also declined due to pumping limitations. Eventually, the total amount of groundwater pumping in the 23 wards decreased from 460,000 m^3 per day in 1971 to 40,000 m^3 per day in 2010.

Contrarily, the Tama Region primarily uses its groundwater for residential use. According to Fig. 7.6, which shows the transition of the amount of groundwater withdrawal by use, residential use has represented about 70% of the total since 1981. The Tama Region has also been involved in a range of applications for ordinances issued by the Tokyo Metropolitan Government that would limit groundwater use. Therefore, industrial use reduced by 50% in the 1970s, and other uses continue

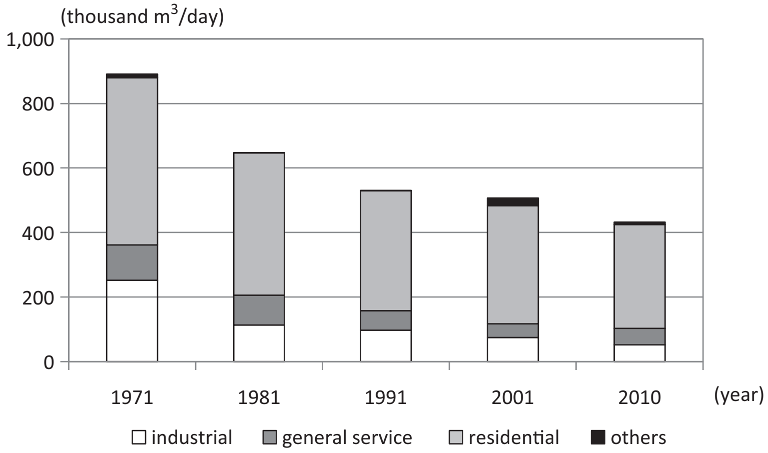

Fig. 7.6 The amount of groundwater withdrawal in Tama Region by use (Yamashita 2013) (Sources: data and materials from Bureau of Environment, Tokyo Metropolitan Government)

to decline. Nevertheless, only residential use maintains its level of pumping compared with industrial and general service uses (Fig. 7.6).

7.4 Groundwater as the Residential Water Source in the Tama Region

The transition of urban water use in Tokyo can generally be summarized as a move toward limiting groundwater use and expanding surface water use. Currently, groundwater is mainly used to meet residential water demand in the Tama Region.

Table 7.3 indicates the amount of groundwater use by municipal waterworks in the Tama Region. According to this table, the Tama Region's municipalities can be categorized into four types. Firstly, municipalities that decreased their groundwater pumping in 2010 to less than 60% of that in 1971 belong to type A (e.g., Fuchu and Tachikawa Cities). Type A public waterworks drastically reduced their groundwater source when they merged with the metropolitan waterworks sourced by surface water. Conversely, municipalities of type B, including Mitaka and Chofu Cities, maintained more than 70% of 1971 groundwater pumping volumes in 2010, despite the integration of their own waterworks into the metropolitan waterworks. The type B municipalities maintain their original groundwater sources while growing demand is met through surface water delivered through the metropolitan waterworks. Type C comprises municipalities that were not integrated into the metropolitan waterworks: Musashino, Akishima, and Hamura Cities. Groundwater use remains stable or is increasing in these municipalities, and they continue to mostly rely upon groundwater sources. Type D represents municipalities that have neither used groundwater in the past nor do so today, or that have used so little intrinsically.

Table 7.3 The amount of groundwater use by municipal waterworks in the Tama Region (Yamashita 2013)

	Municipality	1971	1981	1991	2001	2010
Type A	Fuchu City	45,731	45,717	28,475	28,797	24,677
	Tachikawa City	41,839	38,333	23,922	23,968	12,406
	Nishitokyo City	26,308	16,156	13,948	15,152	10,796
	Kodaira City	21,941	11,576	7,509	9,007	6,136
	Hino City	20,194	21,163	14,286	13,269	7,221
	Machida City	13,716	9,718	6,291	4,487	5,112
	Hachioji City	12,068	7,430	5,680	6,870	2,714
	Higashikurume City	11,162	11,900	5,625	5,141	2,209
	Inagi City	10,399	6,008	4,364	3,068	5,376
	Komae City	9,414	4,506	1,078	2,761	2,706
	Higashi-yamato City	9,180	4,048	2,661	972	2,968
	Musashimurayama City	8,477	3,002	2,989	3,126	3,204
	Tama City	8,010	5,589	4,602	3,722	922
Type B	Mitaka City	41,047	37,267	34,438	33,968	29,811
	Chofu City	27,205	41,093	44,198	43,430	38,378
	Kokubunji City	25,344	22,316	22,572	19,749	21,207
	Koganei City	25,302	23,942	19,037	23,073	20,164
	Kunitachi City	12,247	19,172	13,344	13,533	12,964
	Fussa City	11,360	8,367	9,078	13,345	12,256
	Akiruno City	5,392	8,553	6,216	3,559	5,247
Type C	Musashino City	34,609	29,863	31,043	32,449	39,331
	Akishima City	26,146	28,938	39,411	37,994	36,113
	Hamura City	11,650	16,042	20,193	20,389	19,953
Type D	Kiyose City	10,681	26	7	5	0
	Mizuho Town	1,883	1,463	247	201	0
	Higashimurayama City	1,541	174	0	0	0
	Hinode Town	0	3,689	3,078	2,566	225
	Ohme City	0	0	0	0	0
	Okutama Town	0	0	0	0	0
	Hinohara Village	0	0	0	0	0

Unit: m^3/day. Sources: data and materials from Bureau of Environment, Tokyo Metropolitan Government

The following subsection will explore the transition of groundwater use and the current state of groundwater conservation. Three case municipalities selected from each type, except type D, will be described. The cases include Tachikawa City (type A), Kokubunji City (type B), and Akishima City (type C), which are all adjoining and have similar population sizes. These three cities are located on the Musashino Plateau, and their populations in 2011 were approximately 170,000 (Tachikawa City), 110,000 (Kokubunji City), and 110,000 (Akishima City).

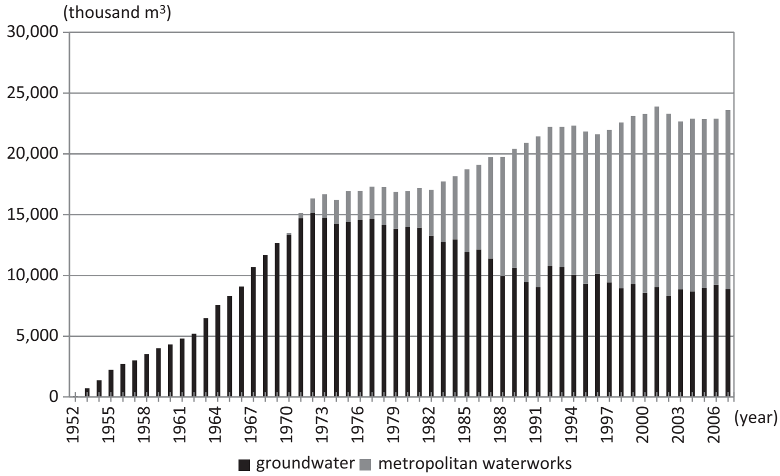

Fig. 7.7 The amount of residential water intake in Tachikawa City by water source (Yamashita 2013) (Sources: data and materials from Tachikawa City)

7.4.1 Transition of Waterworks and Current State of Groundwater Conservation in Municipalities Integrated into the Metropolitan Waterworks

7.4.1.1 Tachikawa City

In 1952, Tachikawa City waterworks started to supply residential water, sourcing from three wells at the time. With urbanization and population growth in the 1950s and 60s, water demand increased, resulting in the expansion of the Tachikawa City waterworks in 1954, 1956, 1960, 1964, and 1967. Consequently, the number of deep wells used as water sources rose to 25 and the amount of water distribution increased exponentially (Fig. 7.7).

As the water demand continued to grow, in 1970, Tachikawa City began receiving residential water from the metropolitan waterworks. While the supply to Tachikawa City from the metropolitan waterworks has increased annually since then, the amount of groundwater use had reduced to two-thirds of its peak level by the end of the 1980s (Fig. 7.7).

Tachikawa City's residential water supply operation was integrated into the metropolitan waterworks in 1982. Though Tachikawa City's groundwater sources continue to be used by the metropolitan waterworks to some extent, the amount of pumping has almost halved (Table 7.3).

To conserve its groundwater environment, Tachikawa City subsidizes the installation of residential rainfall infiltration equipment. Tachikawa City promotes other protective groundwater measures, such as the construction of rainfall storage facilities. However, such measures do not do so much for groundwater recharge and water conservation but they do for storm-water management and the prevention of urban flooding. The Basic Environmental Plan in 1999 and the Comprehensive Development Plan in 2000 referred to these as measures for conserving water and restricting groundwater pumping. Conversely, the Environmental Action Plan, published in 2010 after the waterworks integration, did not mention these two goals regarding sustainable groundwater use.

7.4.1.2 Kokubunji City

In 1960, Kokubunji local government dug a deep well to a depth of 170 m in Higashikoigakubo, in the eastern part of the city, to provide a public water supply service. By 1974, Kokubunji City was operating two waterworks expansion projects. Consequently, Kokubunji City became equipped with 15 deep wells as water sources and three water treatment plants, and its water distribution capacity continued to significantly grow (Fig. 7.8). During this period, water demand increased with population growth and changes in residential lifestyles. Meanwhile, the resulting decrease in groundwater levels and the increased land subsidence problem became increasingly evident. In response to these environmental problems, Kokubunji City waterworks began to supply its residential water from the metropolitan waterworks in 1967. According to Fig. 7.8, while residential water intake from the metropolitan waterworks continued to mount from the 1970s to the 1990s, it has stabilized in recent years. Although groundwater intake tended to decrease in the 1980s, it has remained at approximately 8,000,000 m^3 per year since the 1990s. Since Kokubunji City integrated its waterworks into the metropolitan waterworks in 1975, it has requested maintaining a 55% local groundwater share for its water source.

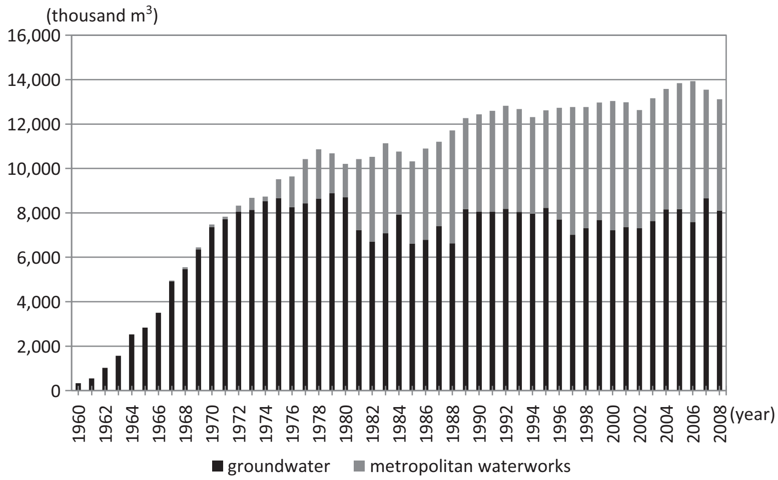

Fig. 7.8 The amount of residential water intake in Kokubunji City by water source (Yamashita 2013) (Sources: data and materials from the Waterworks Department of Kokubunji City)

Kokubunji City groundwater conservation policies include the installation of rainfall infiltration equipment, promotion of permeable pavements, and restoration of traditional wells.

The installation of rainfall infiltration equipment and the promotion of permeable pavements are intended to recharge groundwater and diminish direct rainfall inflow into sewage pipes. Kokubunji City subsidizes all equipment installation costs for residential homes for the former and all construction of permeable walkways with road works for the latter.

The policy of restoring traditional wells helps to establish shallow wells in parks, which act as water supply hubs during times of disaster and as locales for local people's daily interactions. By 2010, 19 wells had been established. These wells are managed by local residents and municipal administration, and are subjected to periodical water quality tests. Some wells serve as venues for monthly local community activities, held for information sharing on groundwater conservation and disaster prevention.

The Kokubunji local government is also active in the conservation and effective usage of spring water and shallow groundwater. It monitors the water quantity of its main springs and the water levels of its shallow wells once per month. Moreover, Kokubunji City enacted an ordinance on the conservation of spring and groundwater in 2012.

7.4.2 Transition of Waterworks and Current State of Groundwater Conservation in a Municipality Not Integrated into the Metropolitan Waterworks: Akishima City

The former Showa and Haijima Towns amalgamated in 1954, becoming Akishima City. Akishima City waterworks were founded in the same year. The first water source well was dug to a depth of 110 m and used to distribute residential water in the former Showa Town. Before the waterworks were created, there were 848 private shallow wells for residential use in Akishima City.

Water demand rapidly increased with industrial and residential development during the period of high economic growth. Accordingly, the Akishima City waterworks conducted a series of expansion projects in 1957, 1961, 1967 and 1978, installing 20 deep wells. Figures 7.9 and 7.10 indicate the transition of the water supplied population, its coverage, the amount of groundwater pumping, and its average daily distribution per capita from 1956 to 2011. While the water supplied population continues to grow, even at present, its coverage grew to over 90% in 1965 and reached almost 100% in 1969. The amount of groundwater withdrawal rapidly increased by 1975, exceeding 10,000,000 m^3. Starting in 1981 it began to increase again, reaching approximately 15,000,000 m^3 in 1992. Subsequently, groundwater intake declined, even as the water supplied population grew, due to a decrease in the average daily distribution per capita. From 1995 onward, the

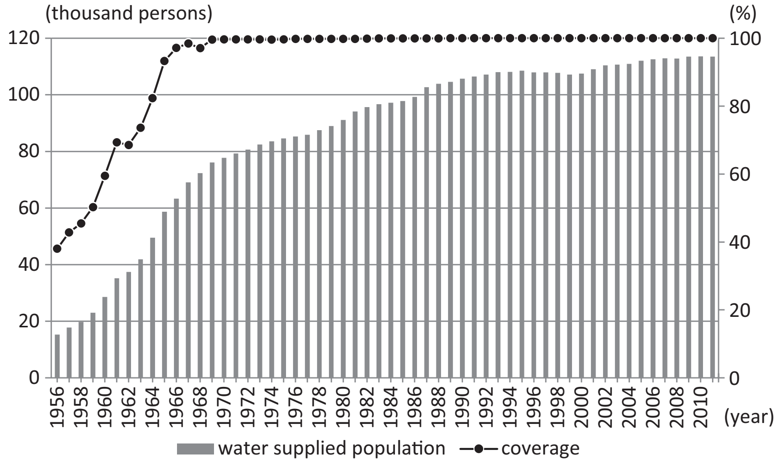

Fig. 7.9 Water supplied population and its coverage in Akishima city (Yamashita 2013) (Sources: data and materials from the Waterworks Department of Akishima City)

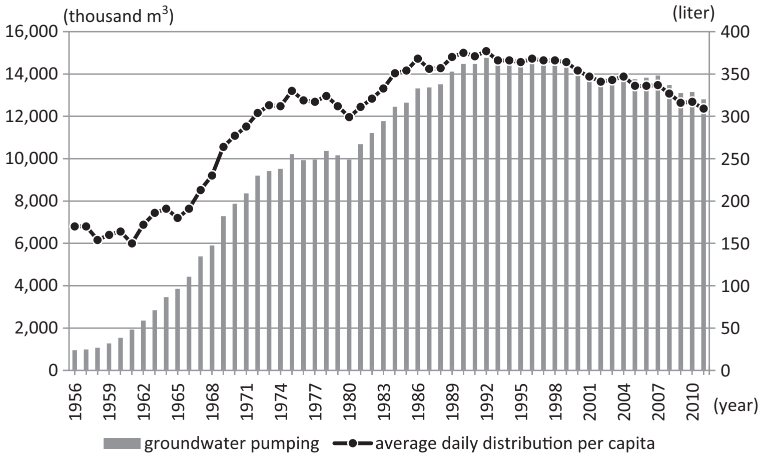

Fig. 7.10 The amount of annual groundwater pumping and its average daily distribution per capita in Akishima City (Yamashita 2013) (Sources: data and materials from the Waterworks Department of Akishima City)

Akishima City waterworks capacity has been 58,300 m^3 per day, following the fifth expansion project. The actual water demand has never exceeded the capacity, and no new water source wells have been dug since 1974.

To maintain the only autonomous waterworks functioning with a 100% groundwater source in Tokyo, Akishima City has implemented measures to stabilize water demand and groundwater recharge. Firstly, since 1974, works have been undertaken to improve the permeability of walkways, roads, and parking spaces. Secondly, rainfall storage facilities and rainfall infiltration equipment installation have been subsidized since 2001.

Furthermore, biannually, Akishima citizens are offered a forest maintenance experience program in the headwaters of the Tama River to promote environmental awareness of their residential water source. Akishima City also conducts several other publicity activities, including waterworks facility tours, delivery lectures, and the publication of newsletters to educate residents about water resource conservation.

Since the foundation of its waterworks in 1954, Akishima City has conducted monthly monitoring of groundwater levels of all water source wells. According to these records, groundwater levels experienced a sharp drop in the early 1970s, recovered somewhat in the 1980s, and stabilized thereafter (Waterworks Department of Akishima City 2005).

Regarding emergency preparedness and water shortages, Akishima City has seven drinking water storage tanks and three water distribution facilities for emergency water. However, to date, these resources have never been used. Meanwhile, about 150 private shallow wells have been used, even at present. Although these wells do not provide potable water, they are available for toilet and bathing uses. Therefore, their conservation and utilization is also important for the securement of emergency water resources.

7.5 Conclusion

As represented by Tokyo, the dramatic development of Japan's big cities in the twentieth century have resulted in the conversion of permeable land cover, such as forest, grassland, and farmland, into impermeable urban land surfaces, composed of concrete and asphalt. Consequently, rainfall on the urban land surface cannot penetrate to underground. Thus, instead of cycling through groundwater recharge, runoff flows over the surface, eventually entering rivers and ditches (Yamashita 2009b, 2011).

The Tokyo metropolitan waterworks originally sourced its supply from surface water. Increased water demand prompted the development of surface water resources in areas outside Tokyo. Despite the increased water demand, groundwater pumping was restricted due to severe land subsidence. Industrial water use shifted the water source from groundwater to surface water with the construction of industrial waterworks. Considering this water source transition in combination with the above-mentioned land cover conversion, Tokyo's urban water supply-demand space shifted from a three-dimensional structure, including underground space, to being widespread and two-dimensional one, excluding underground space.

This spatial shift is modeled in Fig. 7.11. In this figure, the start and end points of each arrow represent the surface water supply and demand area for residential use, respectively. The width of each arrow represents the relative amount of surface water use. The quantitative relation between groundwater pumping and recharge in

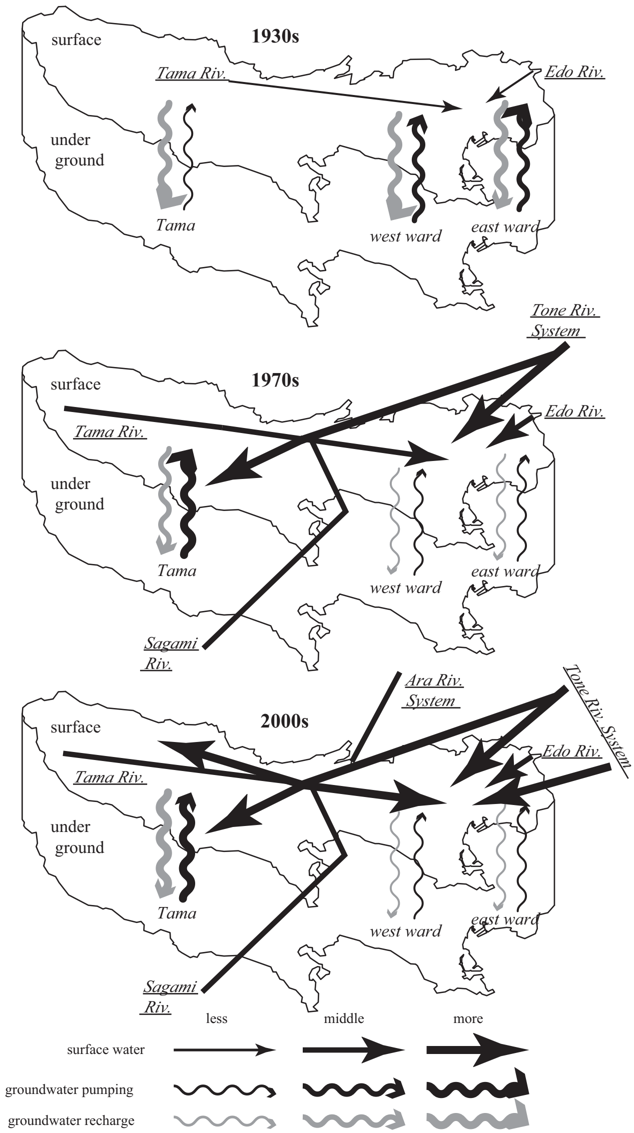

Fig. 7.11 Spatial transition of urban water supply-demand system in Tokyo (Yamashita 2013)

the eastern and western wards and the Tama Region is expressed in the same way in accordance with previous studies (Yamashita et al. 2009; Yamashita 2011).

Residential waterworks in the 1930s were mainly sourced by the inlying Tama and Edo Rivers, and distributed to only the 23 wards. Meanwhile, groundwater was pumped in the 23 wards largely for industrial use. While urban water demand in the Tama Region also depended on groundwater at that time, it was negligible. In the

1970s, the metropolitan waterworks extended its water source to the Sagami and Tone River Systems, with a growth in demand for water distribution to the Tama Region. Very little groundwater was withdrawn for industrial use in the 23 wards; instead, it was pumped from wells in the urbanizing Tama Region. At present, water source areas have spread more broadly to the Tone and Ara River Systems, and the quantity of water distributed to the Tama Region has increased. While groundwater withdrawal in the Tama Region has declined overall, some groundwater sources for residential use continue to be used. On the other hand, in the twentieth century, groundwater recharge decreased as land cover changed from permeable to impermeable. In contrast, efforts to recharge groundwater by rainfall infiltration have recently been promoted in the Tama Region.

During a period of rapid water demand growth, the Tokyo Metropolitan Government conducted its waterworks expansion project, with the enhancement of surface water sources. The government's response thereby contributed considerably to water supply stabilization and calming of the land subsidence problem. In contrast, to the former expansion policy, including development of new surface water resources, alternative measures are required nowadays because water demand has already stagnated or is even decreasing. One good example of this is sustainable groundwater use. Some municipalities in the Tama Region promote policies to maintain their groundwater use and recharge.

In Tachikawa City, the volume of groundwater use had declined by 1990; though usage then stabilized, it has recently decreased again. Enforcement of policies for sustainable groundwater use has also declined. Conversely, groundwater conservation schemes, such as subsidies for rainfall infiltration equipment installation to control storm-water are newly introduced as of 2010.

Kokubunji City maintains groundwater pumping to some extent, even after its waterworks were integrated into the metropolitan waterworks. The city facilitates the spread of rainfall infiltration equipment and permeable pavements, together with the utilization of shallow wells.

Meanwhile, Akishima City waterworks still sources its entire supply from groundwater. According to the Waterworks Basic Plan, established in 2008, "groundwater is our treasure." Thus Akishima City has strongly promoted various efforts to maintain a stable water demand and groundwater recharge. Moreover, Akishima City has never implemented any water supply control measures, even during drought, thereby evidencing the stability of the city's groundwater supply.

According to these three cases, it can be argued that the municipalities reliant upon and properly using groundwater are more active in its conservation. In other words, groundwater conservation depends upon both local government and residents recognizing its value as a water source and, thus, utilizing it practically.

In some cases, water policies address storm-water management through preventing the extension of impermeable urban land cover. These policies include the installation of rainfall storage tanks, rainfall infiltration equipment, and permeable pavements. Such policies should be equally evaluated from another perspective: that of sustainable groundwater use as a local water source.

Even if the operation and management of their urban water supply system has been integrated into the metropolitan waterworks, municipalities should not depend entirely upon large distant water sources, such as dams; instead, they should continue to use local groundwater sources, aiming to secure the supply capacity and maintain the supply-demand balance in each municipality.

While groundwater withdrawal does pose a risk of land subsidence, municipalities should not readily accept large-scale water resources developments in distant headwaters or estuaries of large rivers. To foster sustainable urban water supply systems, efforts are needed to both avoid an increase in water demand and maintain local groundwater resources. Moreover, in terms of water security, at times of disaster or water shortage, sustainable urban water supply systems should include both large-scale extensive systems and locally distributed systems to supplement one another.

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Chapter 8
Food Problems and New Challenges of Urban Agriculture in Tokyo

Ryo Iizuka, Toshio Kikuchi, Tadayuki Miyachi, and Mitsuru Yamamoto

Abstract In the adjacent areas of Tokyo's city center, agriculture has been developed since the seventeenth century, playing an important role in the balance between supply and demand of food in the city. After World War II and the progression of urbanization, Tokyo became reliant on its outer regions for its food supply. The existence of potential food problems inside the city is illustrated by self-sufficiency having become extremely low. Conversely, some of Tokyo's residents have become increasingly interested in food security. Following this trend, some farmers began to introduce new methods of agricultural management to satisfy such residents. This chapter presents an overview of the situation and problems of food balance in Tokyo, and discusses the new challenge of urban agriculture, which can become one of the solutions for food problems. Thus, the case of consumer-participatory style farming-experience gardens in Nerima Ward is introduced. This program is gathering attention from many farmers and civil servants throughout Japan. In farming-experience gardens, a spontaneous and secure food supply is embodied through communities of urban residents led by farmers, becoming a support base of urban agriculture.

Keywords Urban agriculture · Food problems · Urbanization · Farming-experience garden

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8.1 Introduction

Traditionally, Tokyo's food supply was provided by suburban and rural areas. However, those rural areas were subsumed into the city due to the progression and expansion of urbanization, leading to the destruction of crop fields that were formerly a food source for the city. Moreover, due to development of transportation technology, Tokyo's food suppliers increasingly relocated to outside the city, and the quantity of imported food from outside Tokyo increased rapidly.

Regarding the marginalization of food sources in Tokyo, some researchers have traditionally studied the geographical perspective. Using a case study in the dairy industry, Ishihara (1959) identified milk-producing places in Tokyo from the perspective of Thünen's model. In that study, he noted the limitation of Thünen's model, which explains that milk-producing areas are located near city suburbs without considering the progress in transportation and storage. Ishihara explained that milk-producing places had been geographically spread due to those progresses. Later, Saito (1971) revealed the spatial structure of milk sheds in the Greater Tokyo Metropolitan Area. Setting three dairy farming areas extending concentrically from the center of Tokyo, the place of consumption, he revealed that the farthest in that circle of three dairy farming areas is the center of the milk-producing area for Tokyo.

More recently, agriculture inside the urban areas of Tokyo Metropolis has also been researched from a geographical perspective. For example, Takatori (2000) discussed the multiple functions of urban agriculture, concisely analyzing land use change caused by urbanization. She noted that it is a challenge for sustainable urban agriculture to let hide actual operation of land-supply function in multi-functional urban agriculture which changes agricultural lands for urban land use, as security for agricultural management. Miyachi (2006) described the situation and limitation of agricultural land preservation under the 1991 Productive Green Space Act. He argued that the act itself needed to be partly changed, because both the designated areas and designation ratio started decreasing in some municipalities after 2000, in contrast to previous increases in the 1990s. Thus, in geographical studies, the impacts of urbanization in Tokyo, which is somewhat related to food supply, are generally illustrated through focus on changes in agricultural management or land use.

Conversely, most research on food problems has traditionally adopted the perspective of agricultural production. The study of food problems has focused mainly on three themes: (1) the decreasing self-sufficiency ratio due to weakened food production (Motoki 2006; Yamada 2008; Ikegami and Harayama 2011); (2) starvation and satiation caused by shortage and excess (respectively) of food supply (Castro 1952; Patel 2008; Moseley et al. 2014); and (3) geographical misdistribution of food (George 1976; Grigg 1995, 1999; Nestle et al. 2008). Although, as described above, there exists some research on the decrease in Tokyo's farmlands, there has been no research on weakened food supply due to this decrease. Moreover, most research on food problems has focused on the national level, rather than at the metropolitan/urban level. Tokyo's food-balance situation is typical of a food-importing country's capital city, heavily dependent on outside food supplies and suffering from a weak food supply base. However, this tends to ignore the city's serious food problem. Thus, capturing supply and demand of food at the metropolitan/urban level is important for first revealing and then solving food problems in Tokyo. Additionally, in response to food problems, consumers' interest in food security is increasing, and a new style of urban agriculture has emerged for such consumers in Tokyo. In this chapter, we illustrate the situation of food balance and problems in Tokyo and discuss the new challenge of urban agriculture, which can become a solution for the city's food problems.

8.2 Situation and Problems of Food Balance in Tokyo

8.2.1 Urban Agriculture Situation in Tokyo

Changes in cultivated land acreage in Tokyo have been closely related to the city's population increase. In the period of rapid economic growth that began in the late 1950s, a prominent population influx led to an increase in housing demand in Tokyo's suburban areas, where more space for housing development was available. Property prices in those areas soared, and many farmers began converting cultivated lands into residential lands. This change caused a sharp decrease in cultivated land acreage in Tokyo. Moreover, the enactment of the City Planning Act in 1968 further accelerated this transition. In accordance with the new City Planning Act, taxation of fixed property and city planning for cultivated lands in the Urbanization Promotion Area were increased to the same amount as that of residential lots. This increase caused many farmers to sell their cultivated lands as residential lands (Kikuchi and Obara 2004).

According to Fig. 8.1, which shows changes in population and cultivated land acreage in Tokyo, the population increased by about three million in the period from 1955 to 1975. However, cultivated land acreage decreased sharply from 34,500 ha in 1955 to 14,000 ha in 1975. In particular, paddy field cultivation declined from 7146 to 1533 ha during the same period. This indicates that not only paddy fields but also upland fields also were converted to residential lands, due to the rice production adjustment. Conversely, the number of orchards increased temporarily because farmers began to produce fruits, such as persimmon, chestnut, and Japanese apricot, which are labor-saving crops and can be grown while preparing for the conversion of lands from agricultural to residential. However, in the period from the 1990s to the 2000s, those orchards were developed into residential lands to take advantage of their ground stability; the proportion of orchard acreage to cultivated lands, thus, decreased. Overall, there has been a prominent decrease in Tokyo's cultivated lands suitable for food production. Moreover, the gap between demand for food and its production supply has widened due to the increase in population.

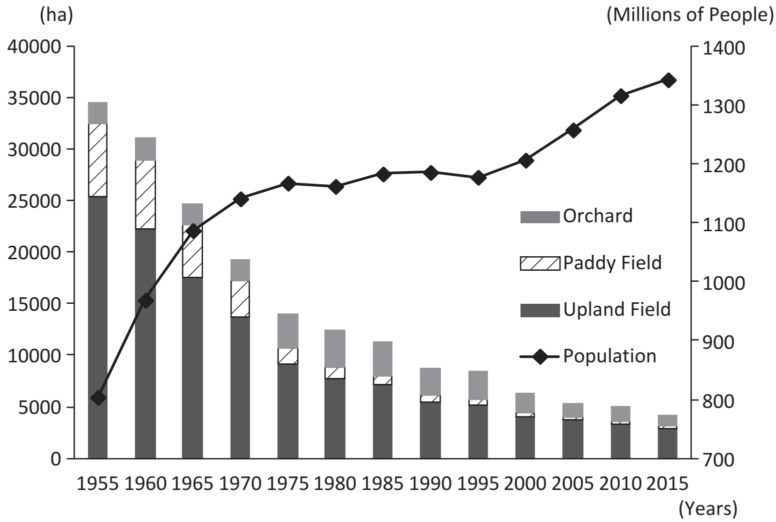

Fig. 8.1 Transition in population and size of cultivated land in Tokyo Metropolis (Data from the Japan census and the Ministry of Agriculture, Forestry and Fisheries (MAFF). Kikuchi and Iizuka 2014)

Although population increased again after 1995, the decrease in the ratio of cultivated lands was relatively small. This smaller decrease was partly achieved by changing some cultivated lands from Urbanization Promotion Areas to Productive Green Zones. However, food production in Tokyo has not increased again. Following changes in the production of rice, wheat, and barley (Fig. 8.2), yields of each crop have been declining sharply. These yield declines are a critical factor in decreasing food self-sufficiency, as these crops are calorie-rich and have become staple food items. Therefore, the decrease in Tokyo's food self-sufficiency ratio is mainly caused by a decline in the production of stable grains. This tendency is reflected by a sharp decrease in the paddy field acreage. In the future, Tokyo's food self-sufficiency ratio will decline further as the continuing progression of urbanization and the aging of farmers will contribute to reduced rice production.

8.2.2 Change in Food Self-Sufficiency Ratio

Figure 8.3 shows a negative correlation between the food self-sufficiency ratio and population by prefecture. Surprisingly, only six prefectures, Hokkaido, Aomori, Akita, Yamagata, Iwate, and Niigata, have a self-sufficiency ratio exceeding 100%. This is mainly due to large-scale farming operations in Hokkaido and the fact that rice production is stable, with a high productivity per unit area due to the progress of farmland consolidations in the other prefectures. However, this means that the remaining prefectures (i.e., other than the aforementioned six) are unable to support themselves and depend on other prefectures and producers in foreign countries.

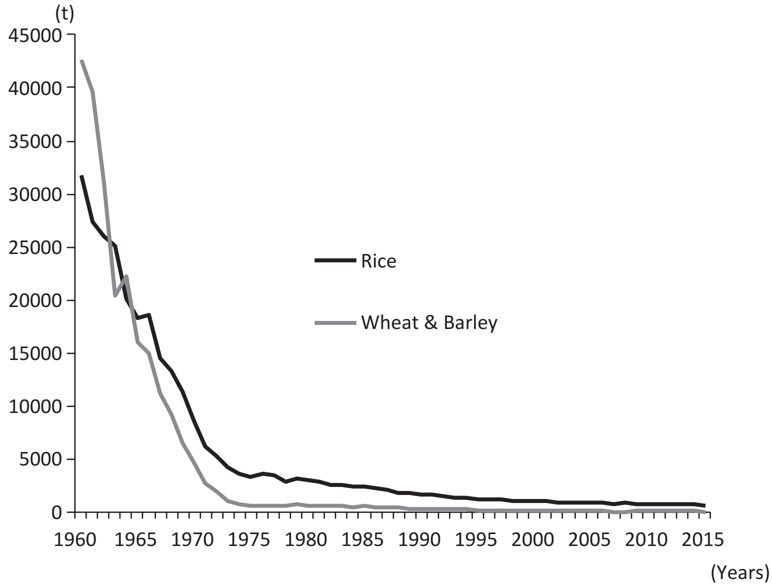

Fig. 8.2 Yields of rice, wheat, and barley in Tokyo Metropolis (Data from the statistical yearbook of the MAFF. Kikuchi and Iizuka 2014)

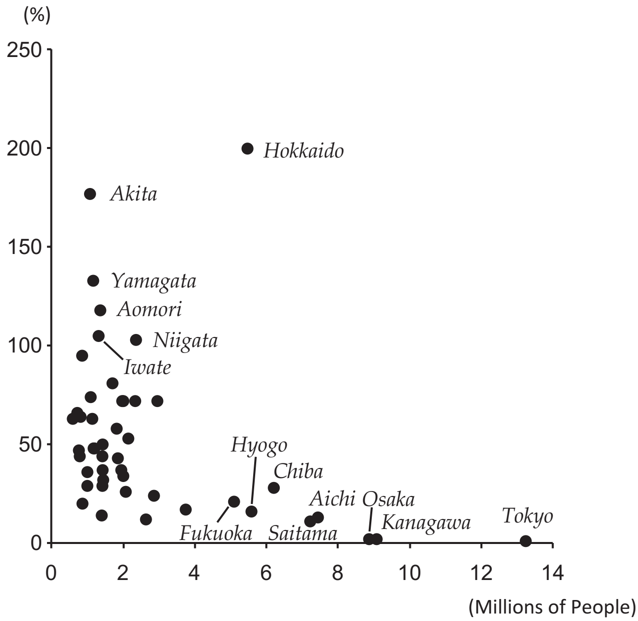

Fig. 8.3 Correlation between food self-sufficiency ratio and population by prefecture in Japan (2012) (Data from the Japan census and the MAFF. Kikuchi and Iizuka 2014)

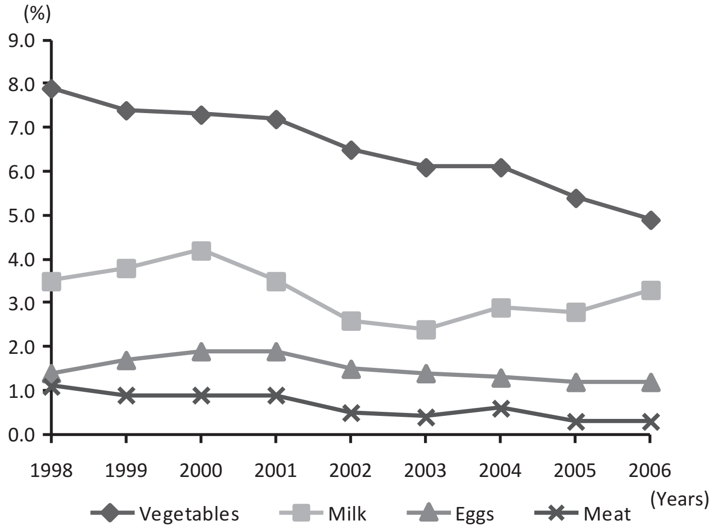

Fig. 8.4 Self-sufficiency ratios of major food items in Tokyo metropolis (Data from Tokyo Metropolitan Gov., and Bureau of Labor and Economic Affairs. Kikuchi and Iizuka 2014)

Such problems are critical within the prefectures of Tokyo, Kanagawa, and Osaka, with food self-sufficiency ratios below 10%. Tokyo's food self-sufficiency ratio is the worst in Japan, at approximately 1%. Thus, it is evident that a critical food crisis could occur should the city's supply be severed in the event of natural disasters.

Figure 8.4 shows the food self-sufficiency ratios of the main food items excluding stable grains from 1998 to 2006, capturing the trend of food self-sufficiency in Tokyo. The graph shows that the self-sufficiency ratio of vegetables decreased consistently in this period. This was caused by both a decrease in supply, due to the decline of cultivated lands, and an increase in demand, due to Tokyo's population influx. Regarding milk, the self-sufficiency ratio differed by year but was stable at around 4% overall. Tokyo's milk self-sufficiency had once been high, based on the supply from dairy farms in urban and suburban areas. However, the ratio declined due to innovation of milk-supply infrastructures, which urged dairy farms to move to suburbs farther from the city, where they were better able to manage vast farms. The self-sufficiency ratio of eggs was stable at a low level with relatively small changes. Conversely, the self-sufficiency ratio of meat, having traditionally been at low levels, decreased greatly in the period, like the self-sufficiency ratio of vegetables.

Overall, the food self-sufficiency ratios in Tokyo have decreased for not only high-calorie items, such as stable grains and meat, but also for vegetables, which are mainly supplied as perishable foods from suburban areas. An important factor behind this trend is the decline of cultivated lands due to the growth of residential areas, resulting in conflict between agricultural and urbanized land use. This weakening of the food production base has become a significant food problem in Tokyo.

8.2.3 New Problems and Movements of Food Supply

Various problems have arisen from the globalization of food supplies in Japan's domestic markets, including the Tokyo market. For instance, the Japanese government enacted safeguards against imported Welsh onions and *shiitake* mushrooms, which increased in numbers for the first time in 1999 due to imports from foreign countries, such as China. The safeguard was an emergency measure to restrict imports when the World Trade Organization (WTO) recognized the danger to domestic industries. In the food supply context, the exercise of safeguards indicates a shrinking and weakening of the food production base due to globalization, as safeguards are implemented in response to rapid increases of certain imports (Kobayashi 1999).

In fact, the amount of imported Welsh onions was under 10,000 t until 1997, when it began to increase rapidly, reaching 42,385 t in 2000: almost five times the 1997 amount. In 2000, the price of imported Welsh onions per kg was about 100 yen, which was half or one-third that of domestic products, as 98% of imported Welsh onions were from China where the production cost was cheap. The low-priced Welsh onions have been sold at supermarkets as bargain goods and have been used in food service industries, but they have also become a threat to domestic producers. In the Tokyo market, Welsh onions have traditionally been supplied from the Tokyo suburbs of Saitama and Ibaraki. Welsh onions have been an important crop, sustaining the suburban agriculture of large cities. Thus, the safeguard was exercised to protect domestic producers of Welsh onions in 1999, restricting imports temporarily and raising tariffs on certain items.

According to Fig. 8.5, imports of Welsh onions have increased rapidly since 1998. This pattern can be attributed to the emergency importation of vegetables by the Japanese government, seeking to restrain rising vegetable prices caused by unseasonable weather in summer 1998. In particular, vast amounts of Welsh onions were imported from China, and distributers in Japan began to trade in Welsh onions from China as a chance for the emergency import act. Imported Welsh onions for the Tokyo market are cultivated in the middle-south shore provinces of China, such as Shandong, Zhejiang, and Fujian, using Japanese seeds. The onions are shipped to Japan after peeling, bundling, and packing into boxes. Low-priced Welsh onions from China attract consumers in the Tokyo market because Welsh onions from China are as high quality as those from Japan. Therefore, the needs of consumers and food service industries caused the rapid increase in Welsh onion imports.

Conversely, the low price of Welsh onions from China was reflective of cheap labor and transportation costs. According to the "Yearbook of Labor Statistics," in 2000, the average monthly income in China was 9955 yen. This figure was far lower than that of Japan (321,000 yen). Transportation costs were about 1.4 yen per kg from Anqiu, a Welsh onion-producing location, to Qingdao, an outer port, and about 10 yen per kg from Qingdao to Tokyo. In total, these transportation costs were the same as the costs of transporting from Ibaraki to Tokyo, which is only about 80 km distance. Furthermore, with the resolution of political instability in China and the

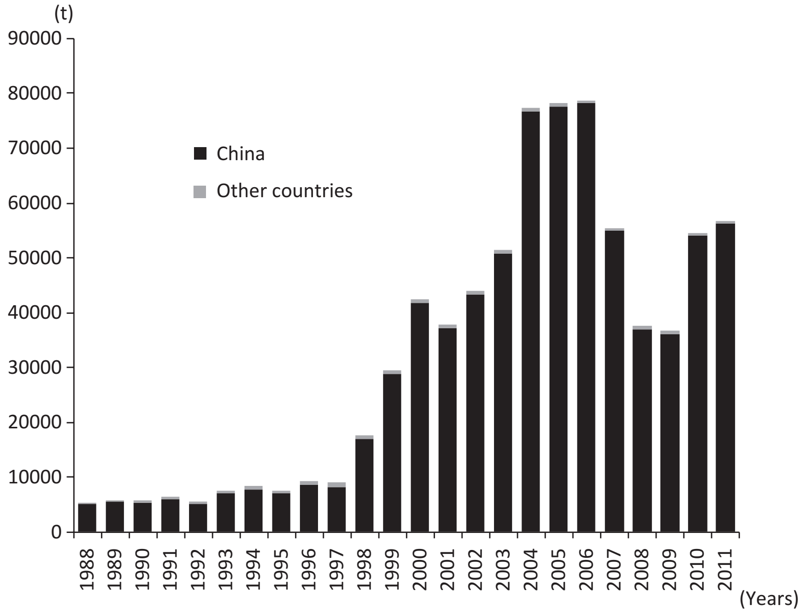

Fig. 8.5 Amounts of Welsh onion imports to Japan (Data from the trade statistics of Japan. Kikuchi and Iizuka 2014)

improvement of its export infrastructures, Welsh onions could be shipped from China to the Tokyo market within about 5 days of harvesting. Therefore, it was obvious that domestic producers would not be able to compete with Chinese production and transportation prices; thus, the temporary safeguard was implemented.

8.3 Movements Supporting Urban Agriculture as a Food Source in Tokyo

8.3.1 Efforts for Preservation of Urban Agriculture in Tokyo

Food problems in Tokyo are related to the security of crop fields as places of food production and supply: in other words, the preservation of urban agriculture. Generally, urban agriculture, which is operated in an Urbanization Promotion Area, had not been considered a target for promotion until the Food, Agriculture and Rural Areas Basic Act of 1999. Its Article 36(2) refers to urban agriculture in the following terms: "with regard to agriculture in and around urban areas, the State is to implement necessary measures for promoting agricultural production that meets the demand from urban residents, taking advantage of the characteristic of proximity to the consumption area" (translated by the Ministry of Justice, Japan. URL: http://www.japaneselawtranslation.go.jp/, accessed December 20, 2016).

Although that sentence remains unclear as regards concrete initiatives, some spontaneous strategies for maintaining urban agriculture and securing outlets are undertaken by public and private bodies in Tokyo. Farm shops managed by farmers and that directly sell agricultural products to urban residents are one example of those strategies. Selling styles are varied, from simply leaving items on the table in front of a farmer's house, shack, or plastic greenhouse, to vending lockers and to the shop buildings of Japan Agricultural Cooperatives. The distributions of these different shops reflect the needs of urban residents, and urban farmers in Tokyo cultivate land based on diversified, small-quantity production, not only because of small farmlands but also in response to those needs (Kikuchi 2008).

With the efforts of *Chisan-Chisho*, meaning "local production for local consumption," and *Shokuiku*, meaning "food education," urban agricultural production is also used for school lunches. However, in many cases, those activities remain occasional because it is difficult for a diversified, small-quantity producer of urban agriculture to meet the demands of a constant supply for school lunches, which need large amounts of food.

In addition, some farmers have recently begun supplying their products directly to restaurants and supermarkets under contracts. In addition to the increasing popularity of farm restaurants using urban agricultural products, a growing number of restaurants in Tokyo are using agricultural products as a means of offering added value: Indeed, some of the city's restaurants exclusively use foods grown and produced in Tokyo.

Thus, urban agriculture in Tokyo is characterized by strategies of grassroots approaches to consumers and securing outlets by making use of the business mind of farmers which is multi-channel supply. Consumer-participatory agriculture, in which consumers themselves participate in farming, is attracting special attention, as it indirectly leads to promoting urban agriculture by improving consumers' comprehension. Thus, in the next subsection we discuss the role of urban agriculture in food problems and the case of Nerima Ward, where such consumer-participatory agriculture is actively operated.

8.3.2 Consumer-Participatory Agriculture in Nerima Ward

Nerima Ward has promoted preservative projects of agriculture much more strongly than many other municipalities in Tokyo Metropolis. This is clearly demonstrated in the kinds of consumer-participatory agriculture operated there. In Nerima Ward, whose entire municipality was designed as an Urbanization Promotion Area, urbanization's impact on the sustainability of agriculture was serious. This is because high taxation on farmlands in Urbanization Promotion Areas became a heavy burden on farmers. Most farmers converted some land use to dwellings and, in the worst cases, some farmers quit agriculture altogether. Therefore, agriculture in Nerima Ward was forced to shrink due to urbanization.

Fig. 8.6 Landscape of ward farm. Photograph by Ryo Iizuka

Thus, the depression of urban agriculture led to the supply of housing property to urban residents. However, this generated various problems, such as deterioration of the residential environment and landscape, decreased opportunity to live close to the soil, and prejudices against farmers. Some urban residents, who found these changes more serious, called for proper city-planning, including the preservation of farmlands.

Responding to their demands, in 1973, Nerima Ward established a “ward farm,” its first farm for recreational use by the ward’s residents (Fig. 8.6). The ward farm was allotted to residents through assignment of farmlands from farmers to the municipality without compensation. At the time of its establishment, the Japanese Agricultural Land Act prohibited farmers from allotting farmlands to ordinal people not engaged in agriculture. In 2016, there were 19 ward farms in Nerima Ward, comprising 1590 lots and 40,051 m^2. Users can cultivate vegetables and flowers freely within their lots for a rental fee of 4800 yen per year. However, farmlands where ward farms are located are convertible to residential land use. In addition, on inheritance, the farm household that owns the inheritable farmland must pay the death duty, which is why the number of ward farms in Nerima Ward has decreased recently.

In 1992, Nerima Ward established another new type of allotment farm, the citizen farm, using farmlands allotted from farmers for profit under the Act on Special

Fig. 8.7 Landscape of citizen farm. Photograph by Ryo Iizuka

Provision of the Farmland and the Act on Promotion of Development of Community Farms (Fig. 8.7). In 2016, there were five citizen farms, comprising 246 lots and 16,248 m^2. As with ward farms, users can cultivate within their lots, but citizen farms have more luxurious amenities, such as private lockers for horticultural tools and a clubhouse (Fig. 8.8). Another difference from ward farms is that citizen farms are located in the Productive Green Zone. This is advantageous because property taxes and city-planning taxes are reduced to the same level as those for farmlands located outside the Urbanization Promotion Area. However, the death duty burden is still left to farmers who own the farmland of citizen farms. In addition, they cannot request the ward mayor to purchase the farmlands of citizen farms, as Article 10 of the Productive Green Act provides that only farmers who engage in farming on the farmlands (thus excluding citizen farms) can request the municipality mayor to purchase those lands. Recently, the number of citizen farms has gradually decreased due to this fatal shortcoming.

Although these two types of consumer-participatory farms were, thus, limited in their preservation of farmlands and enhancing the sustainability of urban agriculture, a new type of consumer-participatory farm that overcame those limitations was established in Nerima Ward in 1996: the “farming-experience garden” (Fig. 8.9). The farming-experience garden is managed by different farmers to those of the ward and citizen farms, which are established and managed by the ward. In this garden,

Fig. 8.8 Clubhouse in citizen farm. Photograph by Ryo Iizuka

Fig. 8.9 Landscape of farming-experience garden. Photograph by Ryo Iizuka

users can grow vegetables from seed to harvest at their allotment under the guidance of the farmer. Such guidance for users is provided through regular lessons that users are responsible for attending. The cultivation period is divided into two terms: the spring cropping term from March to July, and the autumn cropping term from the end of August to the following January. Regular lessons are held about six times per term. Although the frequency and dates of lessons differ from garden to garden, the same lesson is delivered on 3 days – both days of the weekend and one weekday – and twice per day – morning and afternoon – for the users' convenience.

Crops also vary between gardens, and each garden decides which crops to cultivate. In this sense, the farming-experience garden is quite different from other allotment farms (Fig. 8.10). One clear appeal of the farming-experience garden is that a person without any experience growing plants can cultivate delicious and beautiful vegetables with the guidance of farmers and good equipment.

The farming-experience garden is funded through user fees and subsidies from the municipality. The usage fee in 2016 was 50,000 yen, which was reduced to

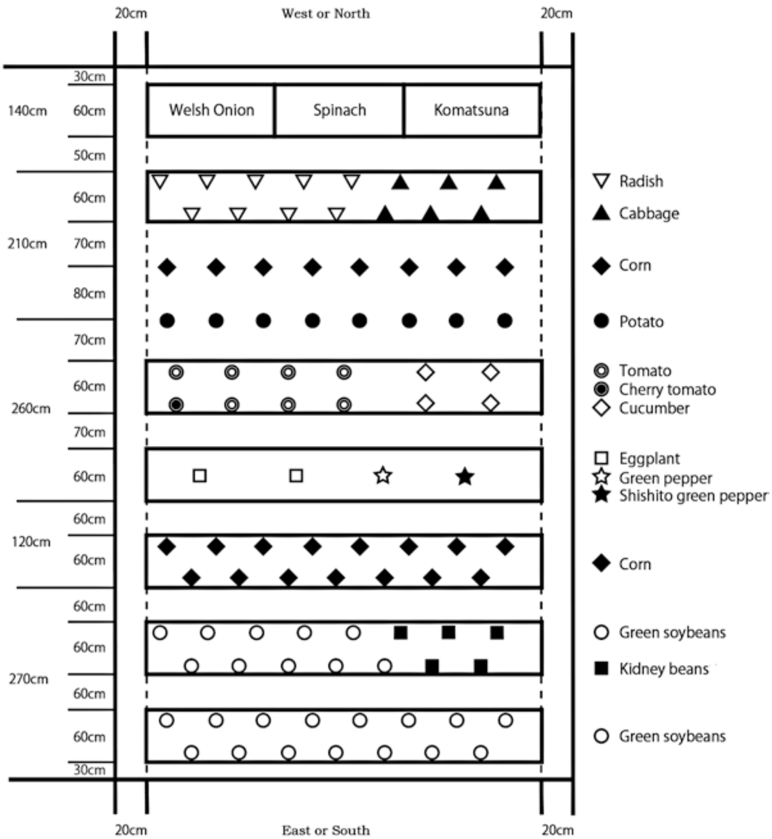

Fig. 8.10 Example of cultivation in one farming-experience garden. Image from field research by the authors

38,000 yen after applying the subsidy for inhabitants of the ward. The 50,000 yen is gross income for farmers. Other than the subsidy for the usage fee, a further six million yen is provided annually by the municipality to subsidize the facilities expenses of all the farming-experience gardens.

8.3.3 Progress of Farming-Experience Gardens in Nerima Ward

Regarding the background of the farming-experience garden project, a series of problems were suffered by both farmers and the ward. On the farmer's side, the 1991 Amending Act of Producing Green Areas forced farmers to take on more efficient or less labor-intensive agriculture through the restructuring of their farmlands. Meanwhile, Nerima Ward struggled to introduce new allotment garden projects due to the lack of success of citizen farms, which had been expected to be a panacea for farmland preservation. Making use of the failure, some innovative farmers collaborated with Nerima Ward and rechecked the law and taxation system for agriculture aiming to introduce a new type of allotment garden. Then, in 1996, the first farming-experience garden, *Midori to Nou no Taikenjuku* ("Experience School of Green and Agriculture"), was established. Since then, the number of farming-experience gardens increased at a rate of one per year. In 2016, there were 17 farming-experience gardens in the ward, but there are no plans to increase this number, to avoid excessive competition between the gardens.

The project of farming-experience gardens in Nerima Ward, called the "Nerima Method," is relatively new and has been introduced to municipalities throughout Japan. In 1998, the Council for Farming-Experience Garden Owners in Nerima Ward was organized to stabilize management of the farming-experience gardens. Council meetings with officials of the ward are held regularly to discuss cultivation techniques and agricultural management. In addition to such meetings, recreational activities, such as an annual trip and picture workshop, are held to keep communications between farmers active. The activities of the council increasingly expanded. In 2002, 35 farmers in Tokyo Metropolis, including farmers from Nerima Ward, organized the Council for Farming-Experience Garden Owners in Tokyo Metropolis. Subsequently, in 2009, the project by the Council for Farming-Experience Garden Owners in Nerima Ward received the grand prize of the Japan Agricultural Award.

The unique advantage of the farming-experience garden model is that it provides benefits for farmers, users, and the municipality. First, farmers can earn a stable income from users and reduce the time they most devote to manuring and harvesting, as the users perform these tasks as part of their farming experience. In this sense, the farming-experience garden is quite labor-saving for farmers. Furthermore, farmers only have to pay property taxes for farming-experience gardens at the level of ordinal farmlands located outside the Urbanization Promotion Area. Farming-experience gardens can be applied to deferred payment of the death duty, because they are legally permitted as one kind of farm managed by farmers in a Green Promotion Area.

Second, the urban-resident users can not only learn about farming and improve their skills but also harvest high quality vegetables. Farmers lecture and teach farming to these users differently from those at standard allotment farms, such as ward farms and citizen farms. Moreover, there are many other benefits, including users' ability to source safe and secured vegetables during the best season and enjoy nature. The monthly class lectures about farming play an important role in establishing a venue for communication amongst users and between users and farmers. Through the class lectures, users not only learn farming techniques but also local history and culture. In addition to the lectures, the harvest festival is an important event for farmers and users of the farming-experience gardens, as the users' family and/or friends can also participate in the event, thus expanding the farming-experience garden community. These communication opportunities improve the value and continuous use of farming-experience gardens. Consequently, in Nerima Ward, there were 2.8 applications for each place at the farming-experience gardens in 2008, higher than the competition for opportunities at ward farms, 1.2 per place, and citizen farms, 1.9 per place.

Third, the benefit for the municipality is the reduction of farms' operation and maintenance costs, due to farming-experience gardens being managed by farmers as an agricultural operation. Through farmland preservation, they can properly secure spaces for green places and evacuation places in the event of natural disaster, and it is easier for them to meet the needs for farming experience.

8.3.4 Case of Farming-Experience Garden: Farmer A

Farmer A, who owns a farming-experience garden, is the head farmer of the household and manages a crop field of 72 Are (7200 m^2). Farmer A worked at a private company for 3 years after graduating from university, but left the company and became a full-time farmer in 1986 because his father, the existing head farmer, passed away. Farmer A had mainly grown specialized cabbages to ship to market. However, since he became a head farmer in 1986, he has tried to promote management reform, making use of the knowledge and skills he learned at the private company. In 1994, he started to sell greenhouse-cultivated tomatoes directly to consumers, but direct selling did not motivate him enough to continue managing the farm. He then heard from his farmer friend about the meaningfulness of farming-experience gardens, a program that had just started in Nerima Ward. He decided to transform the management of his farm and, in 1999, abandoned shipping cabbages to market, transforming the field of cabbages into a farming-experience garden.

Vegetables for direct selling, such as tomato, cucumber, eggplant, cabbage, broccoli, radish, *Komatsuna* (Japanese mustard spinach), spinach, onion, carrot, green soybean and corn are cultivated in 32 Are of the field managed by Farmer A. The other 40 Are of his field is used for the farming-experience garden.

When he first introduced his farming-experience garden, Farmer A experienced difficulty in conveying his agricultural techniques to the farming-experience garden users, but also felt the importance of communication with them. He recognized that the farming-experience garden program, in which farmers and users can share the pleasure of agriculture as well as agricultural techniques, was meaningful. Furthermore, he became more satisfied with farming through the program, demonstrating that the producer can more deeply recognize the appeal of urban agriculture through communication with users. The users became increasingly interested in agriculture and concerned with the problem of food security and the importance of food education. Farmer A derives satisfaction from this program, in which he can share time and space with users who want to learn. He also describes the economic merits of the program as a motive for introducing a farming-experience garden, which makes extensive use of the field, saves agricultural labor, and provides a stable income from the garden's user fees. He will not only manage this farming-experience garden but will also introduce its value to other farmers in Nerima Ward, where few farming-experience gardens are located.

The regular lesson of Farmer A's farming-experience garden is delivered five times per cultivating term at monthly intervals. In the lesson, Farmer A not only lectures users on that day's agricultural works but also conveys information on agricultural events in Nerima Ward. Although users start to work on cultivation individually after the lesson, Farmer A remains in the field to answer users' questions. In Farmer A's farming-experience garden, no finishing time is set and users disperse individually after finishing their day's work, since the degree of skill varies between users. At lunchtime, users communicate with each other over a potluck with vegetables harvested from the garden. The summer and autumn harvest festivals and the *Mochi-tsuki* party, in which boiled rice is pounded into rice cakes, are also held in the garden to promote interaction between users. Users' family members, who do not usually use the garden, are also welcomed at such events, and the garden community expands through their participation and help. Farmer A wants to discuss with users the problems of food supply, the future of urban agriculture, and opinions on agricultural policies, but he values the opinions of and feedback from users without insisting on his own ideas, as he sees building relationships with users to be quite important.

From our research on usage situation of the farming-experience gardens, the users are residents of various neighborhoods and belong to various generations. There exists not only individual use but also couple and family use, especially since family users tend to use the garden to educate their children. Furthermore, in farming-experience gardens, the users' farmer-centered community is formed and promoted by the events held by the farmer and the users.

8.4 Discussion and Conclusion

This chapter has discussed the serious problem of food balance and the new challenge of urban agriculture as a potential solution for food problems in Tokyo. Post-WWII, the food supply base in Tokyo has shifted outside the city, leaving Tokyo dependent on imports from other prefectures and countries. Thus, urban agriculture as a food source has shrunk due to urbanization. However, the style of food supply, which was often under productivism, has been changing in recent years. This is because producers, mainly farmers, and consumers tend to pursue alternative added value, which seems to go against the times, as well as economic value, such as profit, efficiency, and reasonable price. Such calls for added value led to food supplies with security, freshness and/or traceability. Farming-experience gardens in Nerima Ward certainly embody that style of food supply.

Moreover, farming-experiencing gardens also caused a change in farm management. As the food supply inside the city weakens due to the impacts of urbanization and globalization, it is difficult for urban farmers to sustain stable farm management. However, through transformation of farmlands to farming-experience gardens, urban farmers can obtain large profits, such as saved labor and a stable income, making their farm management more sustainable.

The benefits of farming-experience gardens are not only enjoyed by farm managers. The people who support these gardens are the farmers who own them and the local residents. This enables local communities, whose core is the farmers, to form through pursuing farming experiences and/or food security (Fig. 8.11). Those local communities are functional organizations, different from conventional rural communities characterized by kinship, and place importance on interpersonal rather than familial connections. Farmers and urban residents are, therefore, connected

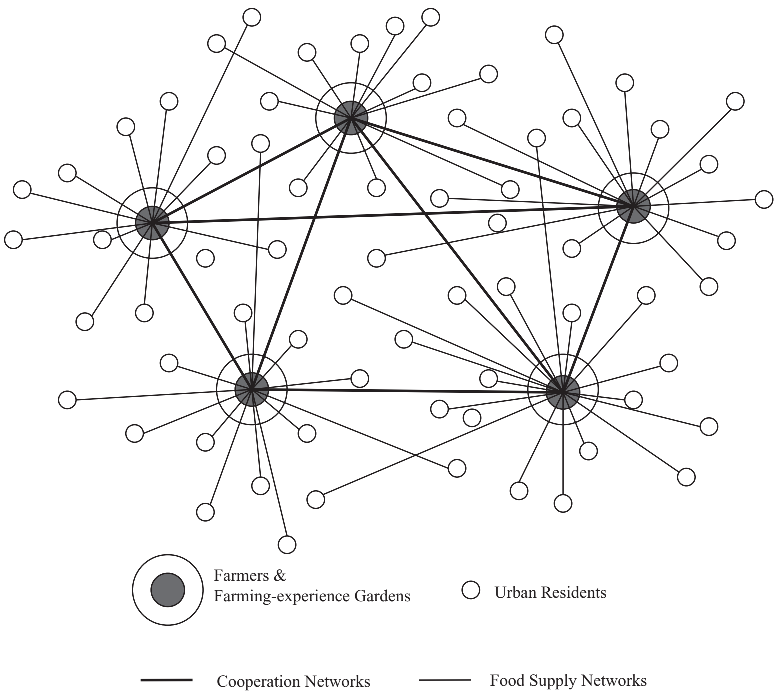

Fig. 8.11 Networks between farmers and urban residents through farming-experience gardens

through supporting urban agriculture and securing food safety. In other words, new local communities organized by farmers and urban residents, through agricultural works and rural space, make the sustainability of urban agriculture more stable.

The local community, whose members are consumers (urban residents) and producers (farmers), thereby restructures the conventional urban food system, helping consumers to understand urban agriculture. Thus, the community provides an ideal food system with security, freshness, and traceability, significantly reducing the distance between producers and consumers. This new challenge of urban agriculture positively demonstrates one way of solving food problems in Tokyo.

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Chapter 9
Spatial Patterns of Population Change in Central Tokyo Since the Period of the Bubble Economy

Yoshiki Wakabayashi and Ryo Koizumi

Abstract This study examines the change in the spatial patterns of demographic structure in central Tokyo since the period of the bubble economy in the late 1980s. To this end, we analyze grid square data suitable for time-series analysis between 1985 and 2005, using Geographic Information Systems (GIS). After selecting major indicators representing three dimensions of the social area analysis – family status, socio-economic status, and ethnic status – we map each indicator and make quantitative comparisons between zones of distance and direction from Tokyo's city center. Focusing on the spatial pattern of population change in the 23 wards between 1985 and 2005, analysis reveals that central Tokyo experienced a population recovery from the latter half of the 1990s, having previously faced a continuing population decline until 1995. On the basis of this population change trend, we examine the spatial pattern of each indicator in the social atlas. Concerning age and household composition, their spatial distribution has gradually shifted from a zonal pattern to a sectoral one, due to the migration of younger nuclear families to the area surrounding the city center. The spatial distribution of socio-economic status, represented by the occupational structure, maintained a sectoral pattern characterized by the contrast between the eastern and western parts of Tokyo, although this distinction has blurred. In particular, the number of managers and officials in the 23 wards has decreased and its distribution shifted to a zonal pattern, indicating the polarization of white-collar workers. The distribution of foreigners shows a zonal pattern, in which the highest value appeared in the area surrounding the city center. However, spatial autocorrelation analysis of the distribution of four major nationalities reveals a clustered pattern, supporting the findings of previous studies in Western countries.

Keywords Social atlas · Social area analysis · GIS · Grid square statistics · Tokyo

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9.1 Introduction

Social atlases were initially made by the Chicago School sociologists as part of their social survey at the beginning of twentieth century. Since then, this kind of map has been made for major cities around the world, becoming a major method for social area analysis. In Tokyo, a group of sociologists (Kurasawa 1986) published the first instance of the social atlas of central Tokyo, namely, the 23 wards of Tokyo. Recently, Kurasawa and Asakawa (2004) upgraded the atlas by expanding the study area to Tokyo metropolitan area (TMA).

These works created not only thematic maps for each variable of subpopulations but also a composite map classifying unit areas based on the cluster analysis. The method for social area analysis was thereby standardized using the multivariate analysis, leading to the development of factorial ecology as a field of urban social geography (Davies 1984; Knox and Pinch 2010).

Several factorial ecology studies have been conducted in central Tokyo: Takano (1979) used 2 km grid-square data for 1970, Sonobe (1985) used 500 m grid-square data for 1980, Yano and Kato (1988) used 1 km grid-square data for 1980, and Ueno (1996) used 1 km grid-square data for 1980. Although it is difficult to compare these studies' results because their input variables and size of unit area vary, two of the three basic dimensions of social area analysis (excluding ethnic status) were commonly obtained in these studies.

From the late twentieth century, it has been easy to make social atlases due to the proliferation of geographic information systems (GIS). Consequently, a group at Ritsumeikan University published an online social atlas for Japan's three major metropolitan areas (http://www.ritsumei.ac.jp/acd/cg/lt/geo/satlas/top/top.html) (accessed January 15, 2014). These social area analysis studies using GIS have led to a new field called "geodemographics" (Harris et al. 2005), a classification of residential areas based on analysis of population data at the small-area level. However, these studies are concerned not with the examination of spatial patterns but rather with their application to businesses.

Our study aims to examine the spatial patterns of population change in the 23 wards of Tokyo after the bubble economy's collapse in the early 1990s. To examine changes over time, we analyze grid square data suitable for time-series analysis between 1985 and 2005, i.e., before and after the bubble economy in Japan. In this period, Japanese society experienced rapid globalization, causing the number of foreigners living in Tokyo to markedly increase. Hence, we added variables of foreigners that were excluded in previous studies in Japan, except for Kirimura (2006).

In the subsequent section, we briefly overview the previous studies of central Tokyo's urban spatial structure to discuss the background to the recent changes. After describing the data and the study's methodology, which takes into consideration the problems of previous studies, we use GIS to analyze the spatial patterns of population change in the 23 wards of Tokyo after the period of the bubble economy.

9.2 Findings of Previous Studies on Spatial Patterns of Population Change in Tokyo

9.2.1 Debate Over Population Change in Tokyo After the Bubble Economy Period

The social area analysis aimed to examine the effects of industrial society's structural change on the social composition within a city (Shevky and Bell 1955). To this end, three basic dimensions, viz., family status, socio-economic status, and ethnic status, were presented as a framework of social area analysis. Previous studies on this topic in Tokyo have sought to verify these dimensions and their spatial patterns. These studies commonly indicate that the family status shows a concentric pattern and the occupation structure, representing socio-economic status, shows a sectoral pattern; however, few have considered the ethnic status dimension, due not only to data limitations but also the small population size of foreigners in Japan. After the period of the bubble economy, however, debate over the structural change in the TMA's population has provoked competing arguments. In this section, we briefly summarize these arguments by focusing on the following three points: population recovery in the central city; social polarization; and the growing number of foreign residents.

9.2.2 Population Recovery in the Central City and Changing Population Composition

From the latter half of the 1990s, population recovery was observed in the central city of Tokyo, where the population had declined by the end of the bubble economy in 1991. Esaki (2006) identified the recent trend of "the end of suburbanization," with low birthrates and aging, as well as a decrease in long-distance population movement. The centripetal population movement was accompanying the decrease in population movement from the 23 wards of Tokyo to the suburbs. However, this trend does not necessarily imply that the population returned to the central city from the suburbs. Instead, it resulted from the tendency of young adults, for whom moving to the suburbs to buy their first house had been considered usual, to remain in the 23 wards of Tokyo (Esaki 2006: 87–88).

This population recovery has been influenced by several factors. Concerning housing provision, the provision of inexpensive condominiums and public housing has increased due to declining land prices after the collapse of the bubble economy (Yamada 2008). Specifically, land developers can easily acquire building sites due to the increase in both real properties sold by companies and the vacant land of former factories and warehouses in Tokyo's inner areas. On the demand side of housing, people prioritizing convenience, such as dual earner households without children, one-person households, and the elderly, have increased (Wakabayashi et al. 2002). In addition, system and policy changes affecting the housing market also promoted this trend. For example, municipalities in central Tokyo enacted regulations obliging new buildings to add houses for population recovery (Kojima et al. 2004; Tsubomoto et al. 2012). After the 1990s, deregulation of floor area ratios under the Building Standard Law, as well as urban renaissance efforts, promoted company investments in real estate (Tomita 2004). Furthermore, a tax benefit for households buying houses with low interest mortgage loans also stimulated housing demand.

Miyazawa and Abe (2005), who examined the change in central Tokyo's population structure between 1995 and 2000, noted a substantial increase in the number of owner-occupiers of apartments, one-person households, married couples without children in their 30s, and white-collar workers with higher educational background. This suggests that residential differentiation linked to economic power and lifestyles had occurred, leading to an increase in the differentiation of population characteristics in central Tokyo. Hence, it is probable that central Tokyo's recent population recovery changed the spatial patterns of the major social area analysis dimensions: family status and socio-economic status.

9.2.3 Social Polarization

Since the 1990s, deepening social polarization due to the globalization and neoliberal policies has been identified in Japan (Tachibanaki 1998; Yamada 2004). Social polarization became particularly apparent in Tokyo, as a world city which is especially subject to globalization. Sonobe (2001) and Machimura (2009) summarized the factors affecting this process into three points: First, Tokyo became a member of the world cities. As Sassen (2001) noted, polarization dividing the elite and the underclass progressed in the world cities, which became a foundation for the international economy, including multinational enterprises. In addition, increasing international competition required companies to adopt a flexible wage system and wage restraint to cut costs (Castells 1989). Second, deindustrialization and the information society caused employment mismatch, separation of the labor market, and a shift to the higher service industry sectors and high-tech industries. In addition, information technologies accompanying standardized duties caused a decrease in the number of clerical jobs and differentiation among white-collar workers. In response, the Japanese Government revised the Worker Dispatching Act since 1999, leading to increases in the irregular employment of young people. Third, neoliberal public policy caused a retreat in welfare and the protection of workers by emphasizing market mechanisms. In accordance with economic globalization and in response to the national finance crisis since the 1980s, the ruling Liberal Democratic Party in Japan adopted a neoliberal policy similar to that of the ruling Republican Party in the US. Specific policy examples include deregulation and the Act on Special Measures Concerning Urban Renaissance in 2002, both promoting urban renewal in the metropolitan core through private companies' capital. Forty percent of the special urban renaissance districts under this act were concentrated in Tokyo's inner area. Global money and funds from local banks flooded into these districts through real estate securitization. Yabe (2008) indicated that the development of real estate securitization promoted diversification of urban space in Tokyo.

A series of studies by urban sociologists has examined social polarization in Japan. Machimura (1994, 2009) analyzed the change in the number of employees by industry in Tokyo during the 1980s, finding a sign of social polarization in the increased establishment of the service industry and white-collar workers. Hashimoto (2011) also identified that the geomorphological boundary between Yamanote Upland and Shitamachi Lowland has corresponded to that of the residents' socio-economic status since the establishment of Tokyo 500 years ago. Urban geographers have also examined this trend for the 23 wards of Tokyo. Narita (2005) analyzed the changes in the socio-economic attributes and income of Tokyo's residents during the 1980s; Toyoda (2011) analyzed changes in income level from 1998 to 2008, reporting that the difference between areas had increased. By employing data on occupational structure and household income, Toyoda (1999) observed new spatial patterns in social polarization, including white-collar inflow to the bay area and an increase in service sector blue-collar workers in and around the sub-centers of Tokyo, namely Shinjuku and Ikebukuro.

9.2.4 Growth in the Number of Foreign Residents

The globalization accompanying the social polarization leads to the increase in foreign workers. Since the period of the bubble economy, in particular, the number of foreign workers has increased dramatically and their nationalities have become increasingly diversified (Shimizu and Nakagawa 2002). Chiba (2001) and Shimizu and Nakagawa (2002), who analyzed the distribution of foreigners and its change in the TMA using municipality-level data, reported that foreigners showed uneven distribution: their ratio to total population is higher in the inner city and periphery of the TMA.

Fukumoto (2010) conducted a comparative study on the segregation of foreigners between Tokyo and Osaka, employing small-area census data (1995, 2000, and 2005) by dividing foreigners into "oldtimers," comprising immigrants from Japan's pre-World War II overseas colonies, including their descendants, and "newcomers," who immigrated to Japan after the late 1980s. Fukumoto's study revealed a notable feature of foreigners in Tokyo: newcomers outnumber oldtimers and foreigners' nationalities are extremely diverse. Concerning the spatial patterns of foreigners, oldtimers tend to form clusters in Arakawa, Shinjuku, and Toshima Wards, while a new cluster of foreigners has formed in Taito and Minato Wards. Recently, the patterns of segregation have been changing due to the development of condominiums in areas of ethnic clustering. However, some groups of foreigners have concentrated in several specific clusters, partially due to discrimination in housing market, though the ratio of foreigners in Tokyo is less than those in Western countries.

The spatial distribution of foreigners and its change falls within the dimension of ethnic status in social area analysis. Nevertheless, previous studies in Japan have paid little attention to this matter. Recently, Kirimura's (2006) study of factorial ecology in Kyoto proved that a dimension of ethnic status was obtained by adding foreign resident variables. Hence, it is necessary to examine the spatial segregation between foreigners to capture the socio-spatial aspects of recent changes in Tokyo.

9.3 Data and Method

9.3.1 Study Area and Data

Figure 9.1 shows the study area, comprising the 23 wards of what has been regarded as central Tokyo in previous studies. A geomorphological boundary dividing this area into Yamanote Upland and Shitamachi Lowland corresponds to the border that has defined not only land use patterns but also residents' socio-economic status since the Edo period (Kaizuka 1979). We focus on the period between 1985, when the bubble economy started, and 2005, after its collapse at the beginning of the 1990s.

We used the grid square statistics as the areal unit of census data. Although there are other small area units, the grid square has the advantage in time series comparison of not being affected changes in administrative boundaries or in the demarcation of enumeration districts by geographical changes. Among different grid square sizes, we chose the 500 m, commonly used in previous social area analysis studies of Tokyo (Kurasawa 1986; Kurasawa and Asakawa 2004). However, we used the unit area of "*chome,*" a subdivision of a municipality, only for foreigners, as detailed data on foreigners by nationality are not available for grid square units. Since we excluded unit areas with less than 100 population from the analysis, the number if unit areas differed between 1985 (2273) and 2005 (2289).

9.3.2 Method for Social Area Analysis

Previous social area analysis studies have usually classified unit areas using factor analysis and cluster analysis. However, time series comparison between clusters for different time points is difficult in cross-sectional analysis of factorial ecology, such as Kurasawa (1986) and Kurasawa and Asakawa (2004). Hence, we create maps and conduct analysis for each variable.

Following previous studies in Tokyo (Sonobe 1985; Yano and Kato 1988), seven variables were selected as indicators characterizing the social area (Table 9.1). Concerning the dimension of family status, we used population growth rate and the elderly ratio. Instead of the crude marriage rate, which was used by the previous studies but is no longer available, we employed the ratio of one-person households, which characterizes the recent family status trend in Japan. As indicators of socio-

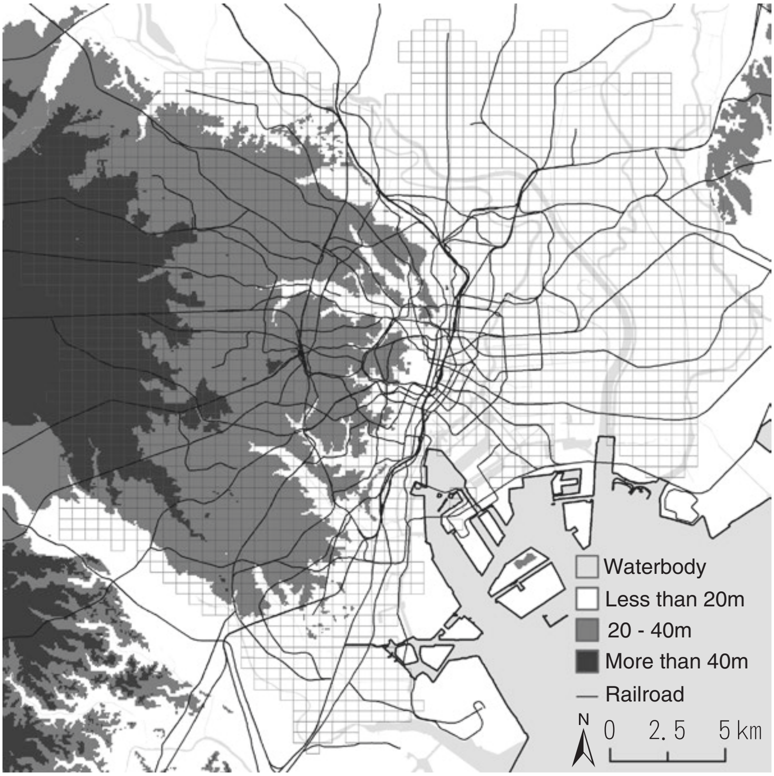

Fig. 9.1 Study area and its topography (Wakabayashi and Koizumi 2014)

Table 9.1 Variables used in this study (Wakabayashi and Koizumi 2014)

Variable	Definition
Age and household	
Ratio of elderly population	Number of people aged 65 or more/Total population
Ratio of young population	Number of people aged less than 15/Total population
One-person household	Number of one-person households/Total households
Occupation	
Ratio of blue collar workers	Number of manufacturing process workers/Total workers
Ratio of administrative and managerial workers	Number of administrative and managerial workers/Total workers
Ratio of professional and engineering workers	Number of professional and engineering workers/Total workers
Foreigners	
Ratio of non-Japanese people	Number of non-Japanese population/Total population
Ratio of non-Japanese people by nationality	Number of non-Japanese population by nationality/Total population

economic status, we selected the ratios of white-collar and blue-collar workers; the former was further subdivided into administrative/managerial workers and professional/engineering workers, since it is probable that white-collar workers have differentiated in the information society.

Concerning ethnic status, we used the ratio of foreigners for 2005, because its data for 1985 were not available. Further, we conducted a detailed analysis of foreigners using data for four major nationalities (Korean, Chinese, American and Filipino) provided by Tokyo Metropolitan Government. To detect clusters for each nationality, we applied the local version of Moran's *I* statistics (Anselin 1995), in a similar manner to Fukumoto (2010).

Based on these data, we made choropleth maps in which class interval was divided by quantile, which is said to be easy to read (Brewer and Pickle 2002). We calculated the breaking value for each class by combining data for 1985 and 2005, except for population growth, to make the class interval common to different time points. To conduct quantitative analysis of spatial patterns represented in the map, we classified unit areas by distance from the city center, and between four sectors classified by direction from the city center to compare aggregated data between classified areas.

9.4 Trend of Population Change in the Social Area Maps

9.4.1 Population Growth in Central Tokyo

The population growth rate between 1985 and 1995 (Fig 9.2a) shows that population declined remarkably in areas close to the city center, reflecting population outflow attributable to soaring land prices in the period of the bubble economy. This result is consistent with the finding of Miyazawa and Abe (2005). However, a marked population increase is observed in the areas where railroad or subway lines newly opened in the 1990s, such as the south of Edogawa Ward, Hikarigaoka housing complex in Nerima Ward, and the north of Itabashi and Adachi wards.

Nevertheless, spatial patterns of population growth changed drastically after the collapse of the bubble economy at the beginning of the 1990s. Figure 9.2b, illustrating population growth in 1995–2005, shows a shift from decrease to increase in areas close to Tokyo's city center. The number of unit areas in which population increased grew markedly from 826 (36.0% of total unit areas) in 1985–1995 to 1532 (67.2% of total unit areas) in 1995–2005. Compared with the trend of population growth in central Tokyo between 1995 and 2000, as represented by Miyazawa and Abe (2005), Fig. 9.2b shows a different pattern, depicting a remarkable increase in the south and east of the central Tokyo. In particular, marked population growth can be observed in the coastal areas of Chuo, Koto, Minato, and Shinagawa Wards, where high-rise condominiums were built on the sites of former factories and warehouses (Hirayama 2006).

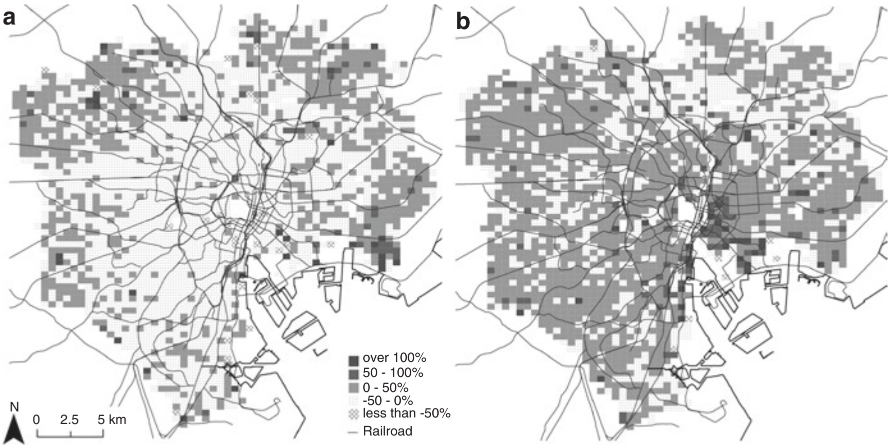

Fig. 9.2 Ratio of population change. (**a**) 1985–1995. (**b**) 1995–2005 (Wakabayashi and Koizumi 2014)

The population growth appearing in these maps reflects both natural increase and social increase. Koike (2010) estimated the value of these two components of population growth between 1980 and 2005 in the TMA. He noted that the social increase spread from the central city to the suburbs, and from west to east, while the natural increase gradually declined in almost all areas, though its decrease in central Tokyo reduced due to the recovery of the working age population. This led to the change in age structure to be explored below.

9.4.2 Age and Household Structure

Social increase within the city is basically affected by residential mobility accompanying the progress of one's life stage. For example, it is assumed that young people who have left their family home will usually live in the inner city close to their workplace or school. With life events, such as marriage, the birth of a baby, and children's growth, as momentum, the assumption is that they then move to the suburbs (Watanabe 1978). In particular, the inflow of baby boomers (born in 1947–1949) to the TMA during the period of high economic growth and their subsequent relocation have considerable influence on the TMA's population structure (Esaki 2006). Consequently, the spatial pattern of the population structure in terms of age and household type become concentric. However, in and around 2000, when baby boomers' children (born in 1971–1974) left home and formed new households, the model of residential mobility can be changed and diversified, as the majority of this age group was born in the TMA (Nakazawa 2011). Hence, spatial patterns of age and household structure are likely to be changed.

9.4.2.1 Young Population

Since the young population usually lives with their parents, their distribution is similar to that of nuclear families. As shown in Fig. 9.3, the ratio of young population shows a concentric pattern; the value is high in the periphery, but high values also appear in eastern districts close to the city center, representing a partially sectoral pattern. This trend corresponds to the result obtained by Kurasawa (1986), who analyzed data for 1975.

Comparison of the maps between 1985 and 2005 reveals that the ratio of young population has declined due to the declining birthrate. In particular, few districts in downtown Tokyo show an increase in the ratio of young population, suggesting that the various measures adopted by municipalities for population recovery, through promoting housing supply, did not necessarily lead to an inflow of nuclear families. However, some districts in east central Tokyo, including Koto, Edogawa, and Adachi Wards, where population recovery is evident in recent years, show growth in the young population ratio.

The background to this trend includes the changing housing market after the collapse of the bubble economy. Yamada's (2008) analysis of condominiums sold in 1995–2005 revealed that a number of relatively low-price properties with wide floor space were supplied in east central Tokyo, located in Shitamachi Lowland. In addition, the housing demand of baby boomers' children, leaving home and seeking to form their own households, also led to the expansion of housing market (Hirayama 2006). Consequently, nuclear families containing the young population have moved into the eastern lowland of central Tokyo. In contrast, the young population ratio has declined in the western part of Tokyo, called Yamanote Upland. Since the land price in this area is relatively high, a shortage of housing supply for nuclear families prevented young people's inflow.

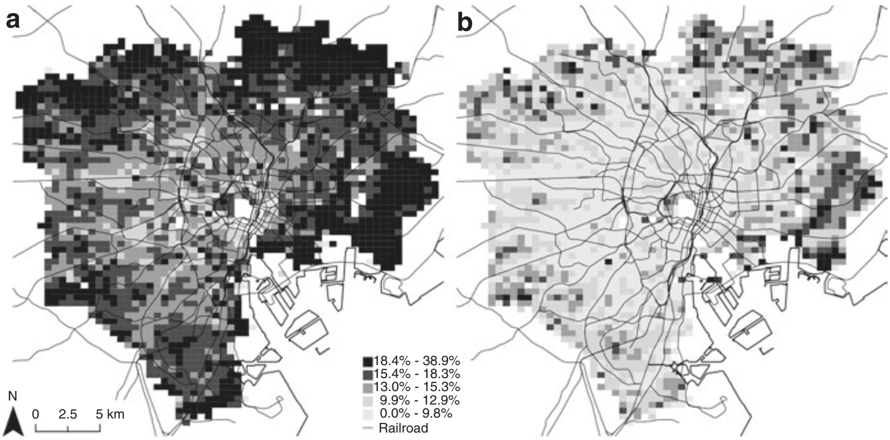

Fig. 9.3 Ratio of young population. (**a**) 1985. (**b**) 2005 (Wakabayashi and Koizumi 2014)

9.4.2.2 Elderly Population

In parallel with Japan's rapidly aging population, the number of elderly in central Tokyo increased from 792,607 (elderly ratio of 9.5%) in 1985 to 1,568,617 (elderly ratio of 18.5%) in 2005. Figure 9.4 shows a concentric pattern of the elderly ratio, being lower in the outer part of central Tokyo. While this trend resembles that observed by Kurasawa (1986), who used data for 1975, the ratio's values consistently increased during the studied period, especially in the east and north sectors of central Tokyo. These areas correspond to the districts where population declined (see Fig. 9.2). Hence, population aging rapidly progressed in these districts because of the limited inflow of young people. In this manner, the concentric pattern of elderly population has become not evident.

Tanaka (2010), who examined the detailed distribution of the elderly by using 250 m grid square data for 2005, classified the clusters densely inhabited by the elderly into three types: standard houses, public housing, and non-house (welfare facilities for elderlies). Applying these types to the clusters of the elderly in Fig. 9.4b, the clusters in the central part inside the Yamanote Line are regarded as general houses; those in the north in Kita and Adachi Wards are public housing; and the sites of large-scale welfare facilities for the elderly are the non-house type located in the periphery of central Tokyo.

9.4.2.3 One-Person Households

Distribution of age structure is closely related to the household composition. According to the household typology of the population census in Japan, private households are divided into one-person households and relatives households, the

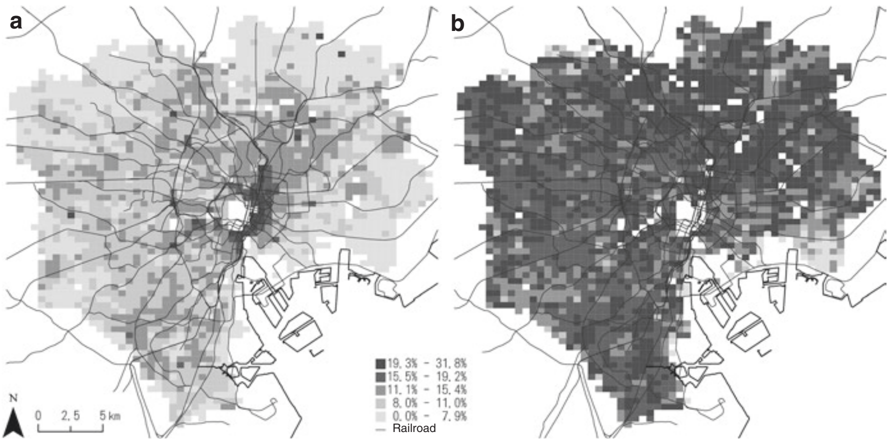

Fig. 9.4 Ratio of elderly population. (**a**) 1985. (**b**) 2005 (Wakabayashi and Koizumi 2014)

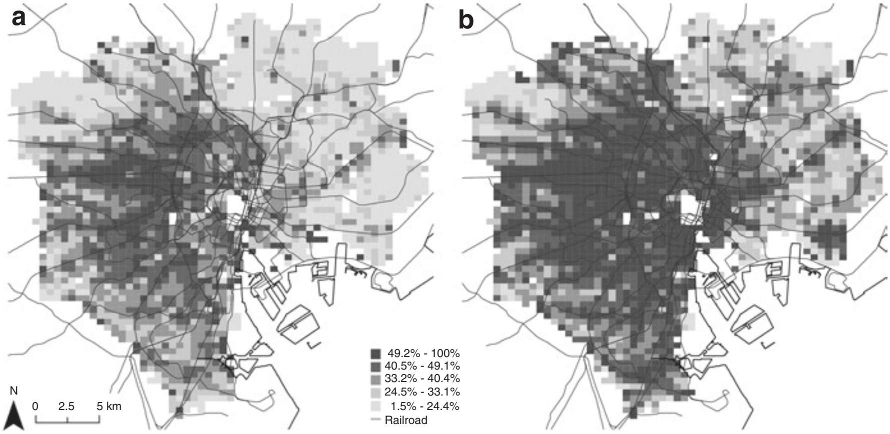

Fig. 9.5 Ratio of one-person households. (**a**) 1985. (**b**) 2005 (Wakabayashi and Koizumi 2014)

latter being further subdivided into nuclear households and other households. Among these types, the number of one-person households has rapidly increased. Figure 9.5 shows that the ratio of one-person households is high in Yamanote Upland, and its value consistently increased in the period between 1985 and 2005. The overall pattern of this trend has not changed from that for 1975, as presented by Kurasawa (1986).

Detailed examination of the maps reveals that districts with a higher ratio of one-person households entirely correspond to the districts with closely-packed wooden apartment houses surrounding the inner area of Tokyo. In 2005, districts with a high ratio of one-person households extended to the eastern side of downtown Tokyo. This reflects not only an increase in singles, owing to the trend of late marriage and the growing supply of apartments for singles (Wakabayashi et al. 2002; Kubo and Yui 2011) but also the growing number of single elderly households. In contrast, districts with a lower ratio of one-person households extend to the eastern part of Tokyo, where the ratio of young people is high (Fig. 9.3). However, the spatial pattern has been changing from a sectoral to a concentric pattern, due to the overall increase in one-person households.

9.4.3 Occupational Structure

While previous studies captured the occupational structure of cities by dividing workers into white-collar and blue-collar, the emergence of the service economy and software industries have led to the growth and diversification of white-collar workers. Consequently, the white-collar worker population rose from 42.2% in 1985 to 44.7% in 2005; in contrast, that of blue-collar workers dropped from 24.4% in 1985 to 18.9% in 2005. Conversely, the composition of white-collar workers has changed due to the restructuring of companies and dissemination of information technologies: the professional and engineering worker population rose from 13.0%

to 16.5%, while that of administrative and managerial workers declined from 6.0% to 3.5% between 1985 and 2005. Hence, we examine the distribution of white-collar workers by dividing them into subgroups.

9.4.3.1 Blue-Collar Workers

Figure 9.6 shows that the ratio of blue-collar workers is higher in Tokyo's east side (Joto district) and south coastal area (Jonan district), being well-known as major agglomerations of factories in the city. These districts formed an industrial community where workers live close to their workplaces and land use is a mixture of residential, commercial, and industrial (Takeuchi 1983). In comparison with the topographic features in Fig. 9.1, districts with a high ratio of blue-collar workers are located mainly in the lowlands close to Tokyo Bay or the major rivers of Tama and Sumida. Consequently, their distribution exhibits a sectoral pattern, which is almost the same as Kurasawa's (1986) map for 1975. In particular, Kurasawa and Asakawa (2004) called the area extending from Joto district to the east side of Saitama Prefecture the "blue-collar belt".

Nevertheless, through a combination of the post-industrial society common to the advanced countries, deindustrialization due to the yen's appreciation, and the restriction of factory locations since the period of high economic growth, both the number of factories and, consequently, the number of blue-collar workers in central Tokyo have declined. A close examination of Fig. 9.6 reveals that the white-collar worker ratio increased in some parts of Tokyo's east side, along Sumida River. In particular, a marked decrease in blue-collar workers is observed in the districts along railroad lines, where white-collar workers have moved into newly developed condominiums. Hence, gentrification can be seen in these districts of the former industrial community.

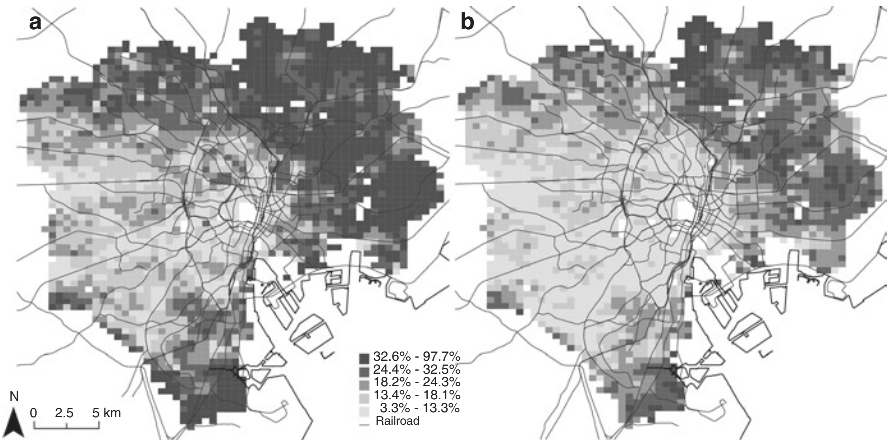

Fig. 9.6 Ratio of blue-collar workers. (**a**) 1985. (**b**) 2005 (Wakabayashi and Koizumi 2014)

9.4.3.2 White-Collar Workers

Previous studies, such as Kurasawa and Asakawa (2004), have commonly identified that the distribution of white-collar workers in central Tokyo shows a sectoral pattern, being high in the west and low in the east. This spatial pattern is also observed in this study, as shown in Fig. 9.6, where a low value means a high ratio of white-collar workers. However, the subgroups of white-collar workers show somewhat different patterns.

The ratio of administrative and managerial workers, as an upper class of white collar workers, showed a sectoral pattern in 1985, but had changed to a concentric pattern in 2005 (Fig. 9.7). Further, the size of this subgroup has decreased, due to company restructuring and the closure of small- and medium-sized enterprises after the collapse of the bubble economy. Consequently, a high ratio of administrative and managerial workers tends to concentrate in districts close to the city center, as well as in well-known, high-class residential areas, such as Denenchofu and Seijo. Specifically, a pattern of low in the north and high in the south is observed within the Yamanote Line. This trend is consistent with the spatial patterns of high-income earners (Tachibanaki and Mori 2009) and income distribution by municipality (Toyoda 2011).

Conversely, the distribution of professional and engineering workers exhibits a sectoral pattern, in which concentration is high in the west and low in the east. As noted above, this subgroup of workers markedly increased between 1985 and 2005 (Fig. 9.8). However, the spatial pattern of professional and engineering workers changed little over these two decades; instead, they remained concentrated in the Yamanote district, on Tokyo's west side.

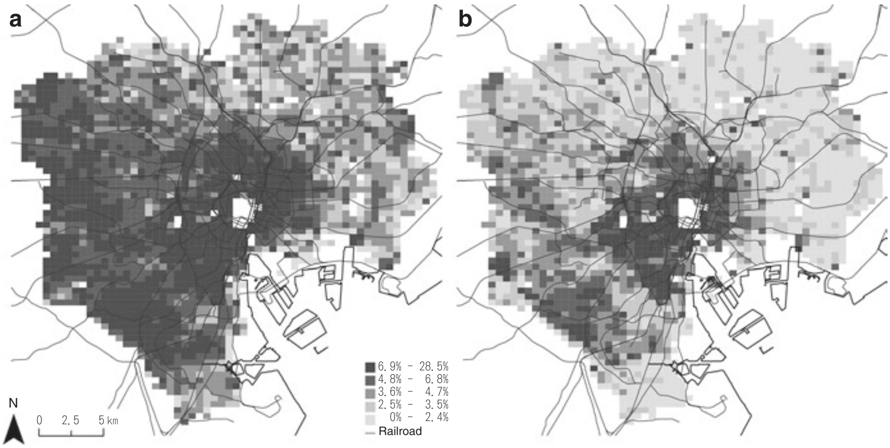

Fig. 9.7 Ratio of administrative and managerial workers. (**a**) 1985. (**b**) 2005 (Wakabayashi and Koizumi 2014)

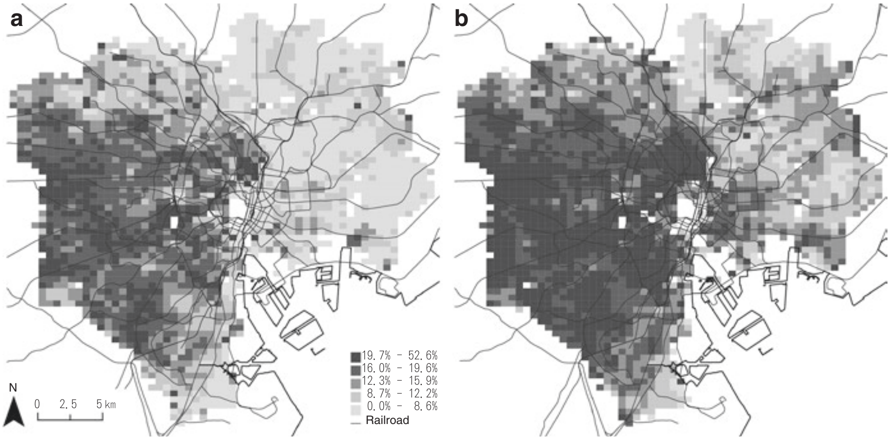

Fig. 9.8 Ratio of professional and engineering workers. (**a**) 1985. (**b**) 2005 (Wakabayashi and Koizumi 2014)

9.4.4 Foreign Residents

From 113,420 in 1985, the number of foreigners in Tokyo Metropolis doubled over the next 20 years, reaching 348,363, and 2.0% of total population in 2005. Since detailed data on foreigners by nationality are not available for small unit areas in 1985, I compared the data for 1995 and 2005. Examination of foreign residents by nationality revealed that the four major nationalities represented 66% of the total foreign population in 2005. The changes in each nationality's share of the total foreign population between 1995 and 2005 are as follows: Korean (from 36.4 to 29.1%); Chinese (from 30.4 to 26.7%); Filipino (from 5.6 to 6.2%), and American (from 5.4 to 4.0%). The actual numbers of Filipinos and Chinese increased, while those of Koreans and Americans declined.

To examine the distribution of foreigners, we made the map shown in Fig. 9.9, indicating the ratio of foreigners to total population for each grid square. As shown in this map, the ratio of foreigners is high in the inner area of Tokyo surrounding the Yamanote Line, where there were many low-cost rental apartments in 1995. However, the districts with a high ratio of foreigners had expanded to Tokyo's east side, namely Adachi, Koto, and Edogawa Wards, in 2005.

To detect ethnic clusters for the four major nationalities, we employed the local version of Moran's *I* statistics (Anselin 1995), in a similar manner to Fukumoto (2010). Since data on the foreign population by nationality are not available for grid squares, we used the data for "*chome*," a subdivision of a municipality. Figure 9.10 shows the areal units included in ethnic clusters for each nationality, being positioned in the first and third quadrant of the Moran's scatter diagram, with p-values for the local Moran's *I* statistic below 0.05.

Concerning Koreans, oldtimer clusters (Fukumoto 2010) are observed in Arakawa, Taito, and Adachi Wards, located to the northeast of central Tokyo, where

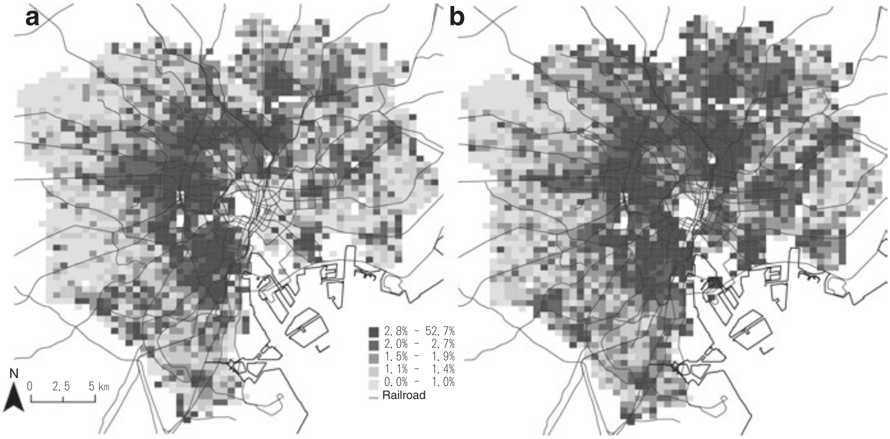

Fig. 9.9 Ratio of foreigners. (**a**) 1995. (**b**) 2005 (Wakabayashi and Koizumi 2014)

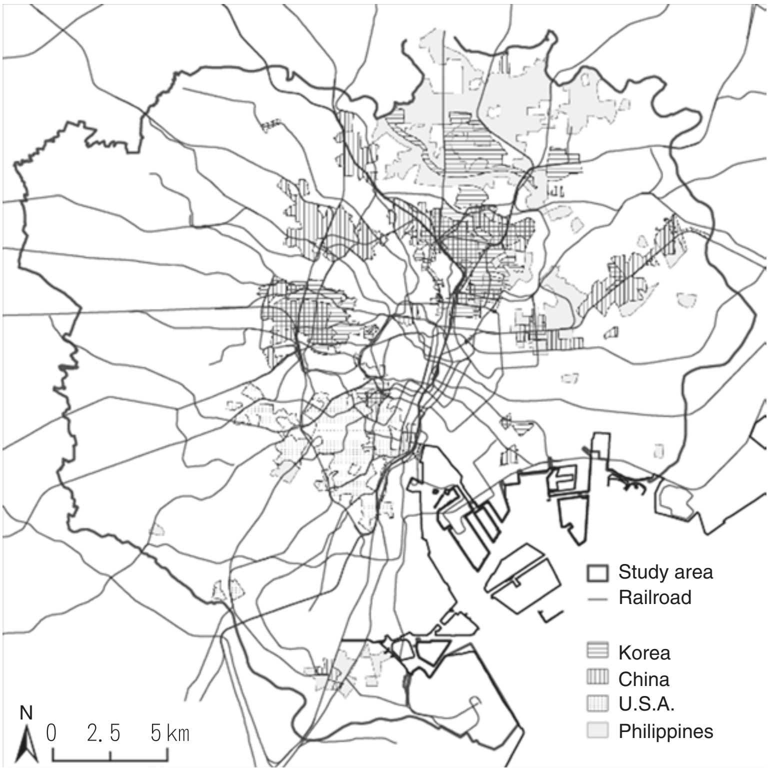

Fig. 9.10 Distribution of the clusters of foreigners by nationality in 2005 (Wakabayashi and Koizumi 2014)

numerous immigrants from Korea settled before the end of World War II. Conversely, there are newcomer clusters in Shinjuku Ward, containing the well-known ethnic town of Okubo district that has become a tourism site.

Ethnic clusters of Chinese partially overlap those of the Koreans in Shinjuku, Arakawa, and Taito Wards, while distinctive clusters are observed in Toshima and Koto Wards. Evidently, the Chinese clusters are mainly located in the north of inner Tokyo, which is similar to the Korean clusters. Yamashita (2011) observed that a number of Chinese students immigrated into districts close to Japanese language schools located near Ikebukuro and Shinjuku Stations after the 1980s. The ethnic clusters outlined above correspond to these areas.

The Filipino clusters spread over Tokyo's inner area, including Adachi, Koto, and Ota Wards, partially overlapping the Chinese clusters. The majority of Filipinos are newcomers, having immigrated after the 1980s, and most are females who have come to Japan to work in service industries. Since some of them have married Japanese husbands, the share of Filipino wives in international couples in Tokyo reached 25.4% in 2005, which was the second highest after Chinese according to the Vital Statistics of Japan in 2005. Hence, ethnic clusters for Filipinos are not evident.

The Americans exhibit a tendency quite different from the Asian ethnic groups. Their ethnic cluster is observed in the south part of central Tokyo, including Minato, Meguro, and Shibuya Wards. Numerous foreigners from other Western counties also live in this area, close to embassies and/or the branch offices of foreign companies.

As shown in Fig. 9.10, segregation is observed in the distribution of foreigners in Tokyo: ethnic groups live in clusters for each nationality. This trend also corresponds to the ethnic status pattern of social area analysis.

9.4.5 *Quantitative Analysis of Spatial Patterns and Their Interrelationships*

To quantitatively examine the spatial patterns observed in this study, we aggregated the unit area into six zones classified by the distance from Tokyo's city center and four sectors based on the direction from Tokyo Central Station. The mean values of each variable by distance zone and direction sector are shown in Tables 9.2 and 9.3.

Family status, represented by the ratios of young population, the elderly, and one-person households, exhibits a concentric pattern (Table 9.2). However, the distinction of the elderly ratio between zones and sectors has blurred in 2005, due to the overall growth of its value. In addition, the ratio of one-person households varies with not only distance from the city center but also direction.

Socio-economic status, represented by the ratios of blue-collar workers and white-collar workers, shows a sectoral pattern characterized by the clear contrast between the east and west sides of Tokyo (Table 9.3). In 2005, this trend become unclear because the ratio of blue-collar workers has declined, while that of the pro-

Table 9.2 Mean value of each indicator by the zone of distance from the city center (Wakabayashi and Koizumi 2014)

Zone	Young population	Elderly population	One-person household	Blue collar	Administrative and managerial	Professional and engineering	Foreigners[a]
(a) 1985							
0–3 km	14.07	14.52	37.69	14.57	10.64	10.75	1.30
3–6 km	16.02	10.07	38.31	21.32	7.65	12.83	3.43
6–9 km	16.19	9.93	36.45	25.90	5.89	12.08	2.73
9–12 km	17.51	8.72	33.60	27.06	5.08	12.04	1.75
12–15 km	19.05	7.99	29.41	28.57	5.71	12.10	1.41
15 km	19.33	7.30	26.36	27.10	6.09	13.87	1.12
(b) 2005							
0–3 km	7.84	20.12	54.68	10.66	7.59	18.40	2.73
3–6 km	9.80	18.27	47.53	14.94	5.07	18.24	4.11
6–9 km	9.70	19.19	45.30	18.81	3.89	16.14	3.02
9–12 km	11.14	17.93	43.10	20.88	2.89	15.49	1.96
12–15 km	12.16	18.08	37.63	22.05	3.17	15.12	1.71
15 km	12.23	17.78	34.46	21.04	3.03	16.51	1.32

[a]Data as of 1995

Table 9.3 Mean value of each indicator by the direction from the city center (Wakabayashi and Koizumi 2014)

Direction	Young population	Elderly population	One-person household	Blue collar	Administrative and managerial	Professional and engineering	Foreigners[a]
(a) 1985							
NW	17.12	8.84	34.63	23.67	14.11	6.12	1.93
SW	16.34	9.45	38.67	20.41	15.58	7.72	2.00
SE	20.95	6.61	28.75	28.07	8.68	4.62	1.71
NE	19.08	8.84	24.08	34.95	7.72	4.53	1.78
(b) 2005							
NW	10.45	18.85	43.50	18.55	17.29	3.43	2.15
SW	10.09	17.65	46.62	15.13	19.20	4.80	2.21
SE	13.12	13.94	38.76	19.29	14.50	3.23	2.28
NE	12.40	19.28	34.38	26.47	11.68	2.58	2.38

[a]Data as of 1995

fessional and engineering workers has increased. In particular, the ratio of administrative and managerial workers shows a marked change from a sectoral pattern to a concentric pattern. Conversely, the rate of foreigners shows a concentric pattern, being highest in the zone of distance between 3 km and 6 km from the city center and declining towards the periphery.

To examine the interrelationship between variables, we conducted a correlation analysis. Table 9.4 shows that positively high or negatively high correlation coefficients are obtained between variables included in the same dimension of social area analysis. However, exceptionally high correlations are observed between some variables belonging to different dimensions. For example, the ratio of blue-collar workers in 1985 has a positive correlation with that of young population and a negative correlation with that of one-person households: this indicates that east side of Tokyo is characterized by not only blue-collar workers but also a young population and nuclear families. While the ratio of administrative and managerial workers in 1985 was positively correlated with the elderly ratio, such a relationship is not evident in 2005. This change may be due to the blurring effect of the elderly population's uneven distribution, due to overall population aging. Conversely, the ratio of professional and engineering workers in 2005 was positively correlated with one-person households. This means that professional and engineering workers of one-person

Table 9.4 Correlation coefficient between variables used in the social area analysis (Wakabayashi and Koizumi 2014)

	Young population	Elderly population	One-person household	Blue collar	Administrative and managerial	
(a) 1985						
Elderly population	−0.657					
One-person household	−0.733	0.312				
Blue collar	0.425	−0.316	−0.515			
Administrative and managerial	−0.318	0.404	0.205	−0.677		
Professional and engineering	−0.325	0.172	0.437	−0.767	0.556	
	Young population	Elderly population	One-person household	Blue collar	Administrative and managerial	Professional and engineering
(b) 2005						
Elderly population	−0.421					
One-person household	−0.732	−0.028				
Blue collar	0.374	0.137	−0.531			
Administrative and managerial	−0.234	0.285	0.220	−0.508		
Professional and engineering	−0.285	−0.161	0.444	−0.783	0.348	
Foreigners	−0.173	−0.054	0.222	−0.131	0.111	0.142

All coefficients except for elderly population and one-person household in 2000 are significant at 0.01 level households tend to live close to their workplaces. In contrast, the ratio of foreigners does not have high a correlation with any of the other variables. This implies the distinctiveness of the spatial pattern of foreign residents in Tokyo.

9.5 Conclusion

This study examined population changes, focusing on its spatial patterns in central Tokyo after the period of the bubble economy. We found that the spatial patterns obtained by the previous studies of Kurasawa (1986) and Kurasawa and Asakawa (2004) were substantially unchanged in 2005: the spatial structure of the social area was maintained. However, we observed some changes between 1985 and 2005.

Concerning age and household composition (representing family status), its spatial distribution has gradually shifted from a zonal pattern to a sectoral one, due to the migration of nuclear families to the area surrounding the city center. The spatial distribution of socio-economic status, represented by the occupational structure, maintained a sectoral pattern characterized by the contrast between the eastern and western parts of Tokyo, although this distinction has blurred. In particular, the number of managers and officials in the 23 wards has decreased and its distribution shifted to a zonal pattern, indicating the polarization of white-collar workers.

The distribution of foreigners, which few previous studies in Japan have considered, shows a zonal pattern, in which the highest value appeared in the area surrounding the city center. However, spatial autocorrelation analysis of the distribution of four major ethnic groups (by nationality) reveals a clustered pattern, supporting the findings of previous studies in Western countries.

Overall, there is a complicated spatial pattern that is difficult to identify as sectoral or concentric. Since the pattern tends to become increasingly complex as a city expands, especially when it becomes large, its spatial pattern can be more complicated at the scale of the metropolitan area, as previously shown by Koizumi and Wakabayashi (2015). Asakawa (2006) examined the change in Tokyo's social area between 1990 and 2000, finding that socio-economic status is ordered by distance from the city center, owing to economic rationality. Consequently, its spatial pattern changed from sectoral to concentric at the scale of the metropolitan area. We observed a similar change in the distribution of administrative and managerial workers. However, it is necessary for us to associate the spatial pattern of central Tokyo with the trend at the metropolitan scale, as the social increase in population can be caused by residential mobility between the central city and the suburbs.

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Chapter 10
Central Tokyo as a Place for Raising Children While Working

Naoto Yabe

Abstract In the late 1990s, central Tokyo began experiencing population recovery, and this trend has continued to the present day. When the population increase during the 2000s is divided into social and natural increases, it can be seen that, during the early 2000s, social increase surpassed natural increase, but in the late 2000s, natural increase grew significantly. An analysis of in-migrants by age group, based on the cohort-change rate method, showed that many incomers were those in their 20s–40s with high fertility, suggesting that the natural increase of the late 2000s was driven by families that moved to the central area and had children. A time use survey of house-wives living in the central area also showed some of the differences between central-city life and suburban life. Central-city residents, as seen from their time use, are characterized by the fact that working wives work longer hours than those in the suburbs. This difference is a result of the greater availability of various employment opportunities, including full-time employment, compared to the suburbs. Also notable is that the percentage of husbands who share housework increased for those living in the central city, as working wives attempt to balance work with housework and childcare under severe time constraints.

Keywords Population recovery · Central city · Time-use survey · Working wives · Tokyo

10.1 Population Recovery in Central Tokyo

Over the 30-year period spanning the 1960s to the 1990s, the population of central Tokyo declined as the suburbanization of the population in the Tokyo metropolitan area (TMA) progressed (Fig. 10.1). The phenomenon of a decline in central city population and an increase in suburbanization is likened to a ring-shaped donut with an empty center, and is widely referred to as the "donut effect." The case of the

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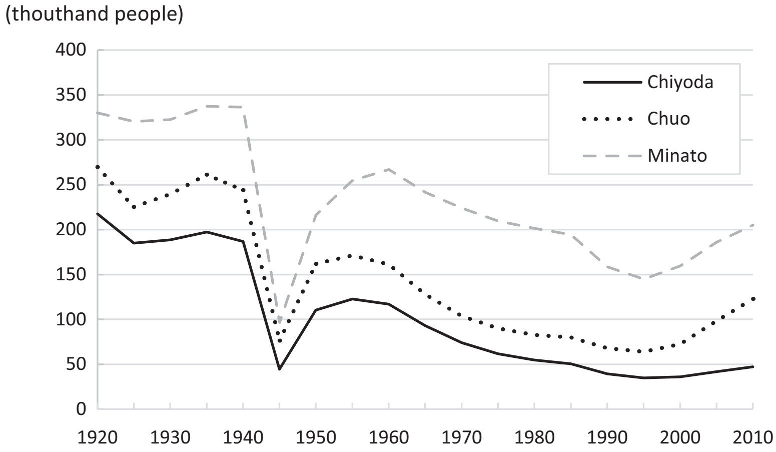


Fig. 10.1 Population of inner three wards (Source: Population census)

TMA during this period can be regarded as a typical example of the donut effect. However, when the bubble economy collapsed in the early 1990s, three wards in central Tokyo – namely Chiyoda, Chuo, and Minato Wards – began to experience population increase, and this trend continued well into the 2000s (Figs. 10.1 and 10.2). This is regarded as a resurgence of the central-city population, meaning that the central city's declining population trend, which had persisted for approximately 30 years after World War II, had been reversed. Concurrently, this could also mean that the suburbanization of the TMA, which had been expanding outwards, has ended (Esaki 2006). The donut that was continually enlarging has stopped expanding and its center has begun to fill, so that it now resembles a filled donut. At this point, the following questions surface: (1) What caused suburbanization to end and the central-city population to recover? and (2) What are the implications of these phenomena? These questions are not easy to answer, and doing so would probably exceed the scope of this chapter; instead, I wish to elucidate some realities of the population recovery to obtain clues that could help to answer these questions. Is there a difference between central-city life and suburban life, just as the cream in the middle tastes different from the dough of the outer donut?

Considerable research has been conducted concerning the recovery of the urban population since the beginning of the 2000s (e.g., Yabe 2003; Yamagami 2003; Esaki 2006). In particular, the population recovery in central Tokyo during the 1990s has been comprehensively analyzed by Miyazawa and Abe (2005), based on small-area census statistics. Therefore, this chapter will use similar statistical data relating to the 2000s to investigate the reality of the population recovery. Now that approximately 20 years have passed since the population recovery began in the late

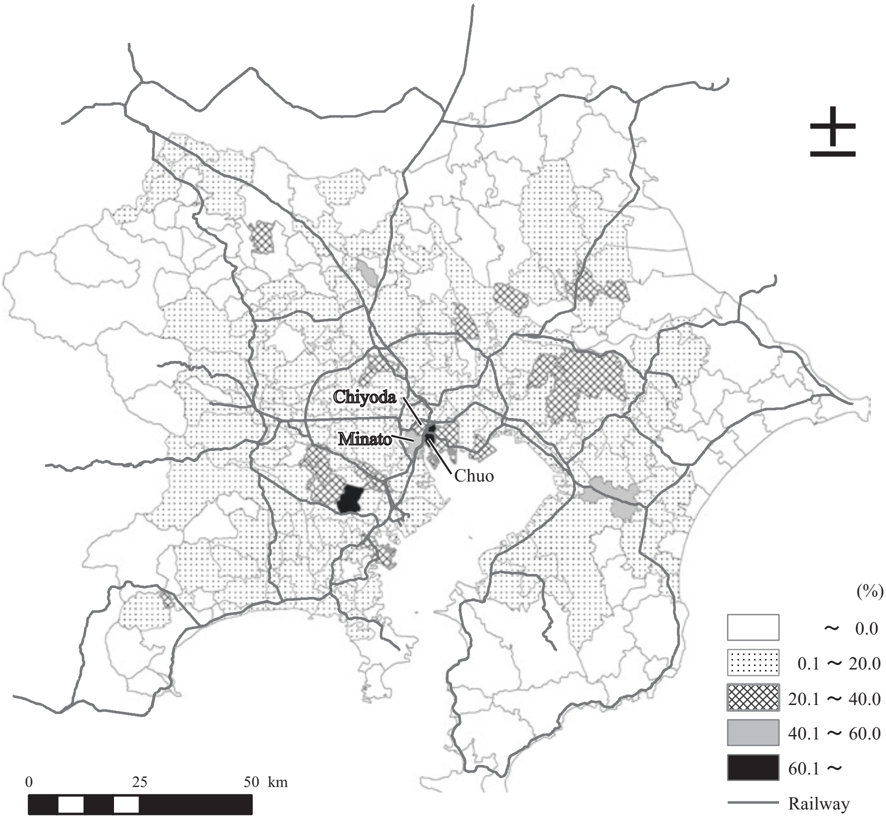


Fig. 10.2 Population increase in the Tokyo metropolitan area from 1995–2010 (Source: Population census)

1990s, this form of analysis should be able to reveal whether there have been any changes in this process. In addition, unlike the situation in the suburbs, where people live away from their workplaces, population recovery means that those who live in the central city now find themselves close to their workplaces; therefore, it would also be interesting to determine how increased workplace proximity has changed the lives of urban residents in comparison to their previous suburban lives. In this chapter, I will present the realities of central-city life based on the results of a time use survey conducted among central-city residents.

Below, Sects. 10.2 and 10.3 will overview the central-city population recovery using municipality-based statistics and small-area statistics, respectively. Section 10.4 will then examine the time-use survey conducted among homemakers residing in the central city, examine how their lives changed when they began living in the central city.

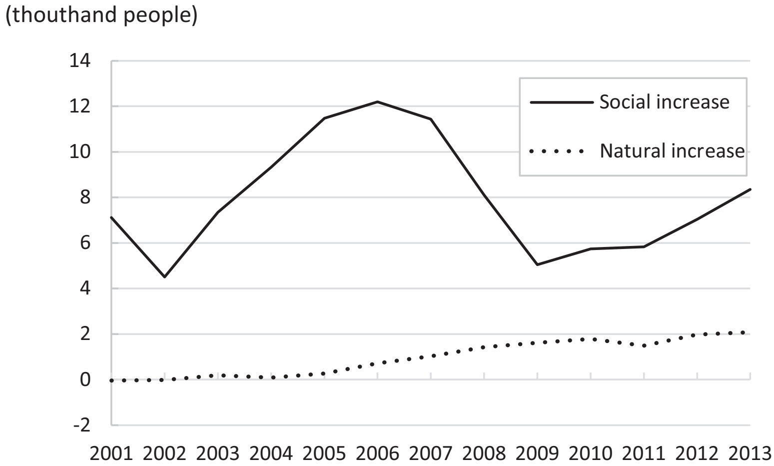


Fig. 10.3 Social increase and natural increase of inner three wards (Source: Annual Report on Tokyo's Population)

10.2 Population Recovery by Municipality as Determined from the Statistics

In this section, I use the census' municipality data and the demographic statistics of Tokyo Prefecture to overview of the central-city population recovery.

10.2.1 Dividing the Population Recovery into Social and Natural Increases

When the population of a given area is growing, its drivers can be divided into social and natural increases. "Social increase" is the number of new residents in the area minus the number of residents who moved out of the area; "natural increase" is the number of births minus the number of deaths in the area. Consequently, population growth can have different implications depending on whether it consists of a larger social or natural increase. Thus, I begin this chapter's analysis by dividing the drivers into these two factors.

Many areas prepare and publish statistical data on the social and natural increases of their population on the Basic Resident Register Network. Being no exception, Tokyo publishes its data as *Jinko no ugoki: Tokyoto no jinko (suikei) nenpo* (Changes in the Population: Annual Report on Tokyo's Population [Estimated]). Here, I use this dataset to examine the population recovery in the three aforementioned wards in central Tokyo (Chiyoda, Chuo, and Minato) by dividing the recovery into social and natural increases.

Considering the changes in the social and natural increases in central Tokyo's three wards since 2001, it is evident that the social increase accounts for a large portion of the recovery (Fig. 10.3). In particular, between 2001 and 2005, there was an average social increase of approximately 8000 people per year; however, the number attributed to the natural increase for the corresponding period is approximately zero. Hence, the population recovery during this period was caused by the number of new residents coming from outside these three wards exceeding the number of residents leaving. Although the social increase declined in 2009 after the collapse of Lehman Brothers, it subsequently regained momentum and recorded an increase of over 8000 people in 2013.

Undoubtedly, the large number of condominiums being constructed in the central city played a large role in this social increase (Hirayama 2006; Kagawa 2014; Kubo 2014). The redevelopment in the central city that begun in the late 1990s had tremendous momentum; condominiums were built as quickly as office buildings were constructed.

However, how did the natural increase change after the 1990s? Having been almost zero in the early 2000s, the natural increase trended upward after 2005, albeit at a slower rate than the social increase. Although this momentum slowed temporarily when the Great East Japan Earthquake and the subsequent accident at the Fukushima Daiichi nuclear power plant occurred in 2011, it began to accelerate again thereafter, and an increase of more than 2000 people was recorded in 2013. While the social increase remains the larger of the two, the natural increase has been growing since the late 2000s at a rate that cannot be ignored.

A natural increase occurs when there is a decreased number of deaths and/or an increased number of births. Looking closely at the numbers for each during this period, the number of deaths remained almost the same, or very slightly increased, but the number of births began increasing significantly in 2005. In other words, the natural increase began in 2005 because the number of births increased but the number of deaths did not.

It should be noted that the percentage of children born in the central city is greater than that in the suburbs. This can be verified by examining the distribution of fertility in 2013 (Fig. 10.4). Fertility, in this case, was calculated by dividing the number of children born in 2013 by the number of women living in the area as of July 1, 2013, and presenting the result as a ratio for every 1000 people living in the area. Considering the distribution of fertility, we can see that fertility in central Tokyo's Chuo Ward (24.6 children) and Minato Ward (24.2 children), which are, respectively, ranked first and second in Tokyo in this regard, is higher than the fertility in urban parts of the suburbs.[1] While suburbanization was still in progress, the central city was where men commuting from the suburbs worked. Meanwhile, as suggested by the commonly applied term "bedroom town," the suburbs used to be a

[1] Third place and below are as follows (in order of ranking): Koto Ward (19.9 children), Inagi City (19.5 children), Shinagawa Ward (19.2 children), Chiyoda Ward (18.5 children), Fuchu City (18.3 children), Edogawa Ward (18.3 children), Koganei City (18.1 children), and Arakawa Ward (18.0 children).

Fig. 10.4 Birth rate of Tokyo Prefecture by city (Source: Annual Report on Tokyo's Population 2013)

place to which men returned after work to sleep and where women performed housework and childcare. However, based on fertility distribution, it seems that the central city is now gradually becoming a place where children are born and raised.

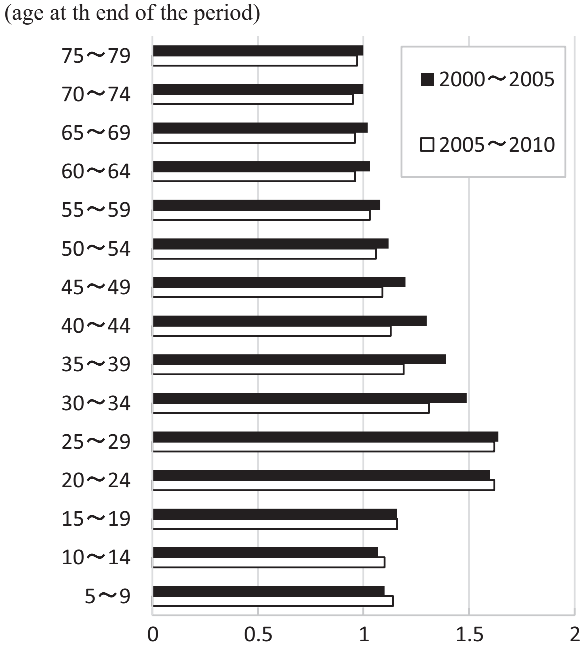
Which people are having children in the central city? One possibility is that residents who moved there before the early 2000s are now having children. To verify this, it is necessary to examine the residents' demographics, such as age and family structure. Using data from the census, I next consider this point further.

10.2.2 Cohort Analysis

First, I will analyze which age groups have migrated to the three wards in central Tokyo. An analysis based on the cohort-change rate method is quite effective in this regard. Similar to the term "generation," the term "cohort" refers to the population of people born during a certain time period. For example, the cohort of people who were 0–4 years old in 2000 turned 5–9 years old 5 years later, in 2005. If there was no social increase during these 5 years, the population of this cohort should remain constant; however, if this cohort's population is larger after 5 years, this means there was a social increase. In this way, the cohort-change rate method is used to study social increase by age group.

Survival rate – the percentage of those who remain alive over a given time period – must be taken into consideration to calculate the exact change in the cohort. This is because there even members of a young age group may die for a variety of reasons, such as accidents; however, this is usually a small percentage. It is self-evident that the survival rate begins to have a significant effect as the cohort ages. Although survival rate varies by region, for the sake of convenience, I have calculated

Fig. 10.5 Cohort-change rates of inner three wards (Source: Population census)



it for each age group based on Japan's national life table, called The 21st Life Tables (Ministry of Health, Labor and Welfare). The cohort-change rate can be calculated by using the following formula.

$$\text{Cohort} - \text{Change Rate} = \frac{\left(\text{Cohort Population at the End of the Period}\right)}{\left(\begin{array}{l}\text{Cohort Population at the Beginning of the Period}\\ \times \text{ Survival Rate of Each Age Group}\end{array}\right)} \quad (10.1)$$

A cohort-change rate greater than 1 means that there were more in-migrants than out-migrants in the cohort. Likewise, when the value is smaller than 1, there were more out-migrants.

The cohort-change rate by age group in the three wards in central Tokyo was calculated for two periods: 2000–2005 and 2005–2010 (Fig. 10.5). The results revealed that the cohort-change rate for those in their 20s exceeded 1.5 and was higher than that of the other age groups in both periods, indicating there was a large number of in-migrants in this age group. For the 2000–2005 period, we can see that there were also large numbers of in-migrants in their 30s–40s, as their cohort-change rates ranged between 1.2 and 1.5. These rates suggest that the population recovery in the early 2000 was mainly driven by people in their 20s–40s migrating to the central city. In contrast, in the late 2000s, the number of in-migrants in their 30s and 40s slightly decreased, and the number of in-migrants in their 20s rose markedly. In particular, it is possible that the large number of in-migrants in their late 20s–40s – the age groups that correspond to the child-raising phase – during the early 2000s became a driver for the natural increase of the late 2000s.

10.2.3 Family Structure and Dwelling Type

To examine the attributes of the central city residents other than their ages, the rate of increase regarding the types of family structure and dwelling was calculated for two periods: 2000–2005 and 2005–2010 (Table 10.1). Note that we must be careful when conducting this examination because there can be two causes of changes in attributes: one is the case in which residents' attributes change due to the arrival of in-migrants to the central city, while the other is the case in which the attributes of residents already living in the central city change. For example, family structure and dwelling type can change as people age. Therefore, we cannot affirm that changes in the residents' attributes found by analyzing rates of increase are all caused by in-migrants. In particular, we must consider that the attributes of a large number of residents who migrated during the early 2000s changed in the late 2000s. These points must be kept in mind as the analysis proceeds.

Examining changes in family structure, an immediately noticeable aspect is that the rate of increase in one-person households exceeded 60% during the early 2000s. In contrast, the rate of increase in households of a married couple with children was low, at 6%. Since the natural increase was also low during this period, there should be relatively few households wherein a married couple without children transition to a married couple with children. In the late 2000s, however, while the rate of increase in one-person households slowed, the rate of increase in households of a

Table 10.1 Family structure and dwelling type of inner three wards (Percentages indicate five-year increasing rate)

	2000	2005	2010
One person household	61,681	99,741 61.7%	105,736 6.0%
Couple only household	22,619	28,076 24.1%	36,471 29.9%
Couple and children household	28,947	30,811 6.4%	37,944 23.2%
Owned houses	55,149	82,157 49.0%	89,087 8.4%
Public rental houses	15,378	18,115 17.8%	18,077 −0.2%
Private rental houses	38,504	57,780 50.1%	75,566 30.8%
Issued houses	14,339	13,857 −3.4%	14,062 1.5%

Source: Population census

married couple and children exceeded 20%. Considering the level of fertility, we can surmise that a considerable number of households transitioned from a married couple only to a married couple with children.

Regarding dwelling type, the number of owner-occupied houses, as well as houses rented from private owners, showed a remarkable increase during the period of 2000–2005. However, the momentum of this increase in owned houses slightly declined during the period spanning 2005–2010. In addition, it has been reported that for households of childless married couples who migrated to the central city, many purchased their house as soon as they were married (Yabe 2003: 289). Based on this, it is also conceivable that childless married couples who purchased a house in the early 2000s had children during the late 2000s, consequently transitioning to married couples with children.

10.2.4 Employed Persons' Industries and Occupations

I also wish to calculate the rate of increase and the component ratio of the industries and occupations of central city residents, and to examine the attributes of in-migrants to the central city. Assuming that work does not change in as short a time period as do family structure and dwelling type, we should be able to infer, to some extent the attributes of in-migrants to the central city based on changes in their rate of increase and component ratio. Since the industry and occupation classifications in the census were revised during the period of 2000–2010, we must be careful regarding the differences between the categories in each period. Here, I used the categories of the 2005 census survey to compare 2000 and 2005, and those of the 2010 census survey to compare 2005 and 2010.

In terms of the changes in the number of persons employed by industries from 2000–2005, a significant increase is evident in such industries as information and communications, finance and insurance, medical care and welfare, and education and learning support (Table 10.2). Conversely, those that declined considerably include construction, wholesale and retail, and restaurant and hotel businesses. The changes in the number of employed persons by industry from 2005 to 2010 also show similar trends to the prior period.

Regarding the changes in the number of employed persons by occupation, a tendency for the number of white-collar workers to increase while blue-collar workers decrease is observed (Table 10.3). The categories that increased during both periods are professional and engineering workers, clerical workers, and security workers. Administrative/managerial workers and sales persons also increased during the period of 2005–2010. Meanwhile, a decrease was observed in service workers and those involved in manufacturing processes.

Table 10.2 Employed persons' industry of central city residents

	2000 (%)	2005 (%)	Increasing rate 2000~2005	2005 (%)	2010 (%)	Increasing rate 2005~2010
Agriculture	0.1	0.1	−33.6	0.1	0.1	−38.2
Construction	3.2	2.7	−17.7	2.9	2.5	−6.5
Manufacturing	7.9	7.9	−2.3	7.5	7.4	8.5
Electricity/gas/water	0.4	0.4	−3.5	0.4	0.4	5.8
Information/ communications	6.2	7.3	16.8	8.2	10.3	38.0
Transport	3.7	3.5	−7.6	3.6	3.7	12.2
Wholesale/retail	22.2	19.4	−14.1	19.4	17.6	−0.6
Finance/insurance	4.2	4.8	12.1	4.6	6.8	62.7
Real estate	6.1	5.8	−7.0	6.1	6.2	13.3
Restaurant/hotel	12.9	10.5	−20.8	11.4	9.0	−13.4
Medical care/welfare	5.9	7.4	23.2	7.1	7.9	21.5
Education/learning support	3.2	3.7	10.7	3.6	3.9	19.3
Scientific research	–	–	–	8.6	10.4	31.7
Living-related/personal services	–	–	–	3.9	3.6	0.9
Compound services	0.8	1.1	33.1	1.2	0.3	−68.4
Services	19.1	21.5	9.9	7.4	6.1	−9.3
Government	4.2	4.1	−3.6	3.9	3.8	9.5

Source: Population census

Table 10.3 Employed persons' occupation of central city residents

	2000 (%)	2005 (%)	Increasing rate 2000~2005	2005 (%)	2010 (%)	Increasing rate 2005~2010
Professional and engineering	17.7	20.3	14.1	20.1	24.1	31.9
Administrative and managerial	8.1	7.8	−4.8	7.7	8.4	20.5
Clerical	24.8	26.5	5.8	26.4	28.3	18.2
Sales	20.6	19.1	−7.9	17.9	16.6	2.4
Service	14.0	12.9	−8.7	14.9	12.1	−10.2
Security	1.8	2.0	12.9	2.0	1.8	2.2
Agriculture, forestry and fishery	0.1	0.0	−30.9	0.1	0.0	−56.8
Transport and machine operation	1.6	1.4	−13.3	–	–	–
Manufacturing process	11.4	10.1	−11.5	11.0	8.6	−14.3

Source: Population census

10.2.5 Image of In-Migrants to the Central City

A brief summary of the findings from the statistics by municipality follows. When the population recovery during the 2000s is divided into social and natural increases, it is found that the social increase surpassed the natural increase during the early 2000s, and the natural increase grew in the late 2000s to a scale that is no longer negligible. Analysis of in-migrants by age group, based on the cohort-change rate method, showed that many in-migrants were individuals in their 20s–40s with high fertility, suggesting that the natural increase in the late 2000s was driven by families that migrated to the central city and then had children. In addition, in the examination of the attributes of in-migrants based on industrial and occupational changes, white-collar workers in industries such as information and communications, finance, insurance, medical care, and welfare are prominent. In particular, since administrative/managerial workers, professional/engineering workers, and clerical workers showed a larger growth in the three wards than the increase for the entirety of Tokyo's 23 wards, these white-collar workers must have played a major role in the population recovery.

10.3 Population Recovery Examined Through Small-Area Statistics

In this section, I use small-area census statistics aggregated by town and section to analyze the recovery of the central-city population. Statistical data by municipality is unable to indicate differences between smaller areas within the three wards in central Tokyo. The districts in the central-city space are not homogeneous; using small-area statistics should show the characteristics of each area.

10.3.1 Identifying Areas with Increased Population

The population growth rates for small areas during the periods of 2000–2005 and 2005–2010 were calculated and mapped for Tokyo's 23 wards (Fig. 10.6). Among the central city and its surrounding areas, the areas where we can observe population increase during both periods are the Jinbocho neighborhood in Chiyoda Ward, Chuo Ward, the Hongo neighborhood in Bunkyo Ward, and the Sumida/Koto area (Fig. 10.7). While population growth is observed in the early 2000s in areas such as Akasaka, Konan, and Azabu in Minato Ward, this momentum seems to have deteriorated in the late 2000s. Meanwhile, areas where the population began growing anew in the late 2000s include Ikebukuro and Ueno. Below, I examine the areas where the population began increasing in the late 2000s, as well as those where the population increased during both periods, calculate the cohort-change rate by age

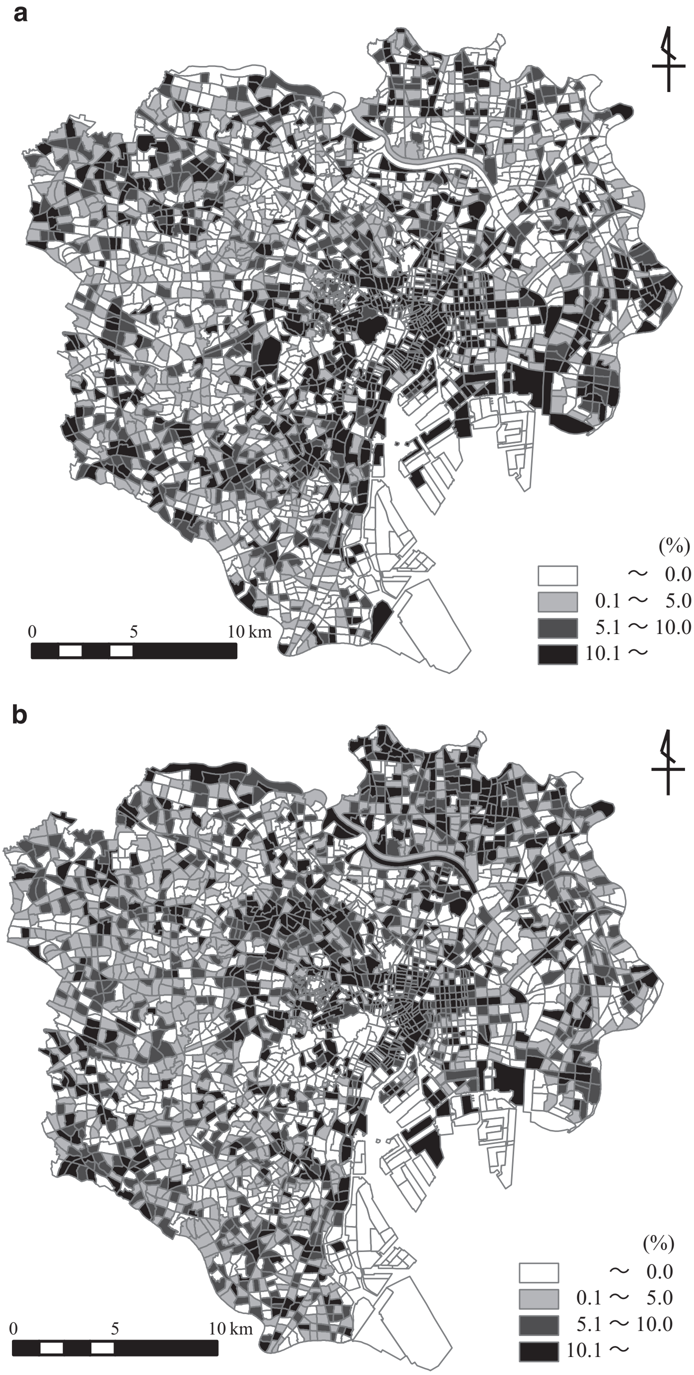


Fig. 10.6 Population increase in Tokyo's 23 wards by small-area. (**a**) 2000–2005 (**b**) 2005–2010 (Source: Population census)

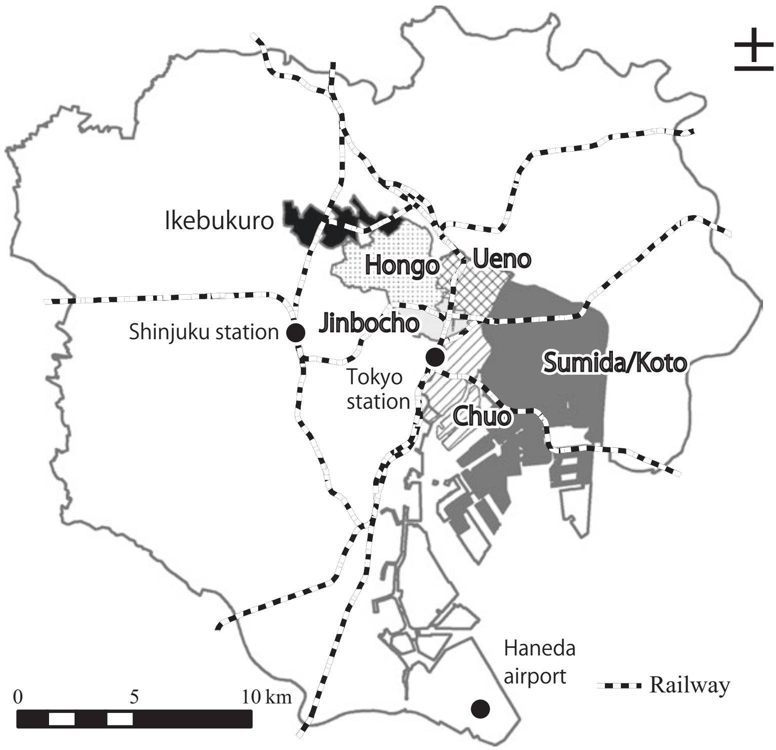


Fig. 10.7 Location of population increasing area

group and the rate of increase of various attributes among the residents, and examine what types of residents increased during the population recovery.[2]

10.3.2 Analysis of the Period from 2000–2005

For each four areas (Jinbocho, Chuo Ward, Hongo, and Sumida/Koto) where population increase was observed during this period, the cohort-change rate and the rate of increase of each attribute were calculated. The overall average for the four areas was then calculated. Subsequently, the average cohort-change rate in each area and the average rate of increase for each attribute were calculated to extract the items showing a value exceeding the overall average for the four areas by 10 points

[2] Sub-regional data were not retabulated after the industry and occupation classifications were changed in the census. Therefore, I was unable to calculate the rate of increase by industry. Regarding occupation, I calculated the rate of increase for 2005–2010 by combining the re-vised categories (the transportation and communication jobs, and the manufacturing jobs).

Table 10.4 Characteristics of population increased area (2000–2005)

	Age of the end of the period	Family type	Dwellings	Sex of workers	Occupation
Jinbocho	5~9 15~29 35~39	–	Private rental, Issued	–	Professional
Chuo	5~9 20~59	–	Private rental, Issued	–	Professional, Clerical
Hongo	20~24	–	–	–	Manufacturing
Sumida/ Koto	10~14 25~29 60~69	One person, Couple only, Couple and children	Owned	Male, Female	Managerial, Clerical, Sales, Service, Manufacturing

Source: Population census

(Table 10.4). This enabled the examination of items showing a characteristic increase in each area relative to all the areas where the population increased.

Based on the cohort-change rates, a social increase can be found for the age groups corresponding to children and their parents in all areas other than Hongo. Sumida/Koto is characterized by the fact that elderly people also moved there. Examining family structure, for one-person households, households with a married couple only, and households comprising a married couple with children, significant increases can be found in Sumida/Koto. In terms of dwelling type, the number of rented and issued houses increased in Jinbocho and Chuo Ward, while the number of owned houses increased in Sumida/Koto. Regarding workers by sex, the number of both male and female workers increased in Sumida/Koto. For occupation, the number of professional workers increased in Jinbocho and Chuo Ward, while a wide range of occupations increased in Sumida/Koto. This suggests that the manner of population recovery in Jinbocho and Chuo Ward, located closer to the central city, differs from that in Sumida/Koto, located just outside the central city.

10.3.3 Analysis of the Period 2005–2010

Examining the six areas where a population increase was observed during this period, I perform the same procedure as described in Sect. 10.3.2 and examine those categories that showed a characteristic increase (Table 10.5).

In terms of the cohort-change rate, an increase can be observed in the age groups corresponding to children and their parents in Jinbocho, Chuo Ward, and Sumida/Koto. Meanwhile, younger in-migrants in their early 20s are conspicuous in areas such as Hongo, Ueno, and Ikebukuro. Regarding family structure, an increase in one-person households was observed in Jinbocho, while increases in married

Table 10.5 Characteristics of population increased area (2005–2010)

	Age of the end of the period	Family type	Dwellings	Sex of workers	Occupation
Jinbocho	5~9 25~29 45~49	One-person	Private rental, Issued	Male	Professional, Managerial
Chuo	5~39 45~49 55~59	Couple only	Owned, Public rental	Male, Female	Professional, Managerial, Clerical, Service, Manufacturing
Hongo	20~24	–	–	–	–
Ueno	20~24	–	–	–	–
Ikebukuro	20~24	–	Public rental	–	–
Sumida/ Koto	5~9 15~19 25~44 50~69	Couple only, Couple and children	Private rental, Issued	Female	Sales, Security

Source: Population census

couple-only households and households of a married couple with children are found in Chuo Ward and Sumida/Koto. The number of female workers also increased in both Chuo Ward and Sumida/Koto. In terms of occupation, an increase in professional workers and managers can be observed in Jinbocho, located close to the central city, as well as in Chuo Ward, while the number of sales persons and security workers notably increased in Sumida/Koto, located just outside of the central city. A wide variety of occupations increased in Chuo Ward; in addition to clerical and service workers, the number of workers in manufacturing – or blue-collar workers – also increased.

10.3.4 Differences in In-Migrants to the Central City by Area

The above analysis suggests that, though they are all part of the same population recovery, districts that received families headed by an individual in his/her late 20s or older, and who were preparing to have children, differ from those that were the destinations of families headed by an individual in his/her early 20s, who had moved to the area upon completing education or gaining employment. Specifically, whereas age groups corresponding to children and their parents migrated to areas such as Jinbocho, Chuo Ward, and Sumida/Koto, those in their early 20s migrated to areas such as Hongo, Ueno, and Ikebukuro. This trend remained consistent from the early 2000s to the late 2000s. Another characteristic is that the number of upper-class white-collar workers, such as managers and professional workers, increased in Jinbocho, which is located close to the central city, as well as in Chuo Ward.

Looking particularly at the areas where the population in the age groups corresponding to children and their parents is increasing, it was found that the number of female workers concurrently increased in such areas as Chuo Ward and Sumida/Koto. Based on this, we can presume that the number of households that include women balancing employment with housework and childcare, or two-income households, increased in the central city and its surrounding areas. In other words, a life-style that differs from that of the typical household in the suburbs (i.e., where the husband is a full-time employee and the wife is a full-time homemaker) is emerging in the central city. In the following section, I examine the reality of those women balancing employment with housework and childcare by analyzing a time-use survey.

10.4 Population Recovery Viewed Using Time-Use Survey

In this section, I conduct a time-use survey to understand the lives of people in double-income households with children.[3]

10.4.1 Overview of the Survey

The time-use survey was conducted in the following manner. Using an online survey panel available through INTAGE, Inc., 646 individuals who met all of the following four conditions were chosen: (1) married woman; (2) residing within one of the three wards in central Tokyo (Chiyoda, Chuo, and Minato Wards) or one of the two wards in Tokyo's subcenter (Shinjuku and Shibuya Wards); (3) employed or full-time homemaker (excluding students); and (4) with children of whom the youngest is under 18 years of age. These selected panel members were asked to participate in the survey on January 17, 2012 (a Tuesday). The responses were taken over the course of 1 week, from January 17 to January 23 (a Monday).

Time use was recorded in a format wherein the respondents provided activity types in 30-minute intervals; for the days when the responses were being collected, they were asked to record their activities for the most recent weekday. Referencing Yano (1995: 45), activities were classified into 11 categories, and the respondents were asked to answer by selecting from the presented choices. In addition to recording activities, they were asked to answer questions about items such as employment status and housework sharing within their households.

There were 336 respondents to the survey: a response rate of 52%. Of these, the responses of 305 individuals (120 working wives and 185 full-time homemakers) were considered valid and were subsequently analyzed.

[3] See Yabe (2014, 2015) for more detailed analysis of this survey.

10.4.2 Overview of Time Use

Different characteristics for time use become apparent when comparing working wives and full-time homemakers (Table 10.6). Inevitably, the greatest difference between them is the number of hours spent working. Since working wives spend an average of 7 h working every weekday, these work hours limit the time allotted to other activities. In this survey, the time working wives devoted to work was approximately 2 h longer than that reported in a time-use survey conducted in Tama New Town, located in the suburbs of the TMA (Sugiura and Miyazawa 2001: 5). This devotion of relatively long hours to work reflects the fact that many women are now working full-time (38.3%).

Time use among working wives shows that, compared to full-time homemakers, they spend a shorter amount of time on almost all activities other than work. Besides work, the only activity to which working wives devote more time than full-time homemakers is travel: whereas working wives spend approximately 1 h on travel, full-time homemakers spend a slightly shorter time. In addition, the percentage of full-time homemakers who travel is only around 30%. This difference is probably because the "travel" described by working wives mainly concerns commuting to work. Assuming that the bulk of this travel is accounted for by commuting, their commuting time must be approximately 45 minutes one way, because the total time they spend on travel is approximately 90 minutes. The afore-mentioned survey results for Tama New Town (Sugiura and Miyazawa 2001: 5) returned approximately the same commute time. This suggests the possibility that, for working wives, the difference between residing in the central city and in the suburbs is a difference in work hours and, therefore, employment type (full-time vs. part-time), since there is a very small difference in commuting time.

Table 10.6 Weekday time budget of housewives

	Working wives		Homemakers	
	Share of participation (%)	Average time	Share of participation (%)	Average time
Sleep	100.0	6 h 40 m	100.0	6 h 59 m
Meals	96.7	1 h 38 m	97.8	1 h 48 m
Personal care	91.7	1 h 44 m	88.0	2 h 24 m
Travel	85.8	1 h 32 m	34.2	1 h 15 m
Work	100.0	6 h 47 m	–	–
Housework	95.8	3 h 24 m	98.4	6 h 35 m
Socializing	25.8	1 h 18 m	43.5	1 h 57 m
Education/ leisure	46.7	1 h 34 m	58.2	2 h 52 m
Rest	55.8	1 h 16 m	62.5	1 h 58 m
Mass media	41.7	1 h 49 m	58.2	3 h 1 m
Other	20.8	1 h 6 m	25.0	2 h 43 m

Source: Questionnaire survey
Modified from Yabe (2014)

Among the activities on which full-time homemakers indicated they spend a longer time than working wives, the largest difference was regarding housework: whereas full-time homemakers spend approximately 6.5 hours per day on housework, working wives spend approximately 3.5 h. Under severe time constraints due to work hours, working wives greatly reduce the time allotted to housework. In addition, the time spent by working wives on such activities as mass-media viewing, education, and leisure is shorter, in each case, by over 1 h, which is a relatively large difference. In general, these results provide a glimpse of the severe time constraints placed on working wives on weekdays.

10.4.3 Things that Support Balancing Work with Housework and Childcare

Working wives' time use differs considerably from that of full-time homemakers. How do working wives manage to balance work with housework and childcare? I discuss this here, based on the survey results.

The results for a question concerning techniques for handling housework and childcare while working (multiple answers were allowed) showed that approximately 75% of working wives listed reducing housework. This is probably related to the time they spend on housework being approximately 3 h shorter than that of full-time homemakers (See Table 10.6). Evidently, determining how to handle housework efficiently in a short time period is the most important issue for working wives when balancing work with housework and childcare.[4]

When we examine activities related to sharing housework with husbands, which includes such categories as taking care of children, taking out the trash, grocery shopping, and cleaning, the husbands' share of housework is also noticeable (Table 10.7). Comparing this housework-sharing situation with the results of the Tama New Town survey (Sugiura and Miyazawa 2001: 8), husbands residing in the central city are more likely to share housework for all categories. It is conceivable that living in the central city affords husbands a shorter commute time than if they were living in the suburbs. Based on the finding that husbands are devoting more time to sharing housework, we may presume that the time saved commuting is allocated to housework.

[4] The work of Kukimoto and Koizumi (2013) serves as a useful reference on the use of nursery schools.

Table 10.7 Division of housework

	Working wives		Homemakers	
	Wife	Husband	Wife	Husband
Preparing breakfast	94.2	13.3	97.8	4.3
Clearing breakfast	91.7	15.0	98.9	3.8
Preparing dinner	98.3	15.0	100.0	4.3
Clearing dinner	92.5	19.2	97.8	13.5
Laundry	95.8	15.0	98.9	10.3
House cleaning	92.5	27.5	98.9	13.5
Shopping	97.5	30.0	99.5	23.8
Take out garbage	72.5	45.8	77.3	48.1
Child care	99.2	48.3	98.4	48.6

Source: Questionnaire survey
Modified and simplified from Yabe (2014)

10.5 Conclusion: The Central City as a Place to Raise Children While Working

This chapter focused on central-city residents and examined the reality of the population recovery in central Tokyo since the beginning of the 2000s. Twenty years after the population recovery began, the emerging picture is that in which the families that migrated to the central city subsequently raised children there. Historically, when suburbanization was in progress in the TMA, central Tokyo specialized as a work district, and people were supposed to raise their children in the suburbs. Although in-migration of one-person households remains ongoing, the population recovery has caused the central city to accommodate a variety of functions, including raising children. It can, thus, be asserted that central Tokyo is now a place for raising children while working.

This sentiment is reflected in the lives of working wives, who balance full-time work with housework and childcare. Central city residents, as seen from their time use, are characterized by the fact that working wives work longer hours than do those in the suburbs. Behind this is the greater availability of various and abundant employment opportunities, including full-time employment, compared to the suburbs. Also notable is that the percentage of husbands who share housework increased as working wives increasingly balanced work with housework and childcare under severe time constraints. The length of time husbands devote to their children seems to also be increasing faster than in the suburbs. It is likely that husbands' change in time-use, through living in the central city, is represented as a decrease in commute time and an increase in the time spent contributing to housework and childcare. Compared to households in the suburbs, the allocation of time-use between husband and wife in the central city has been reorganized.

Unlike the cream in the center of a donut, it does not seem that people can always lead a sweet life in the central city. However, it is certain that a lifestyle differing from the typical life in the suburbs of major metropolitan areas is emerging. The only slightly disturbing finding is that these lifestyles are disproportionately distributed, with particular classes, such as upper-class white-collar workers, adopting this way of living to a much greater degree than other classes.

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Chapter 11
Past, Present, and Future Views in Tokyo

Yu Okamura

Abstract Views within and from a city make spatial experiments productive. These views make it easier to understand the importance of a city's image as held by urban planners and designers. Based on literature reviews and data gathered from the author's research on views in Tokyo, this chapter establishes four phases – "foundation," "creation," "obscuration," and "conservation" – for views in Edo and Tokyo, in the context of urban transformation, and overviews the historical transition of views in Tokyo. Finally, this chapter concludes that we need sophisticated theories and techniques of view management planning to consider how we can create new views, while taking into account existing urban issues; we also need to formulate ideas for taking advantage of views as local resources, to raise a shared awareness of the importance of views in our daily experiences.

Keywords View · Vista · Panorama · Conservation · Town planning · Landscape planning

11.1 Introduction

11.1.1 Expectation for Views in a Town

When the 634-meter-high "Skytree" appeared in eastern Tokyo, many people sought a better place to enjoy a fine view of the building, as well as a better visual composition, for example, through the river from Jikken Bridge, the upside-down reflection in Sumida Park, an exclusive view from a flat's balcony, etc. It remains fresh in our minds that these actions were repeatedly reported in some TV programs, newspapers, or magazines every day.

Such views within and from a city increases the richness of our spatial experience, as we can enjoy walking around the town glancing at specific landmarks such

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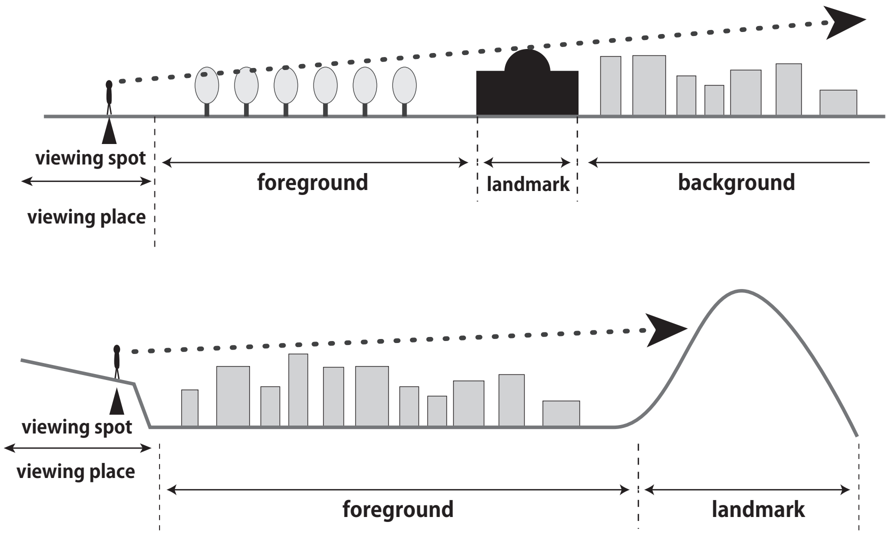

Fig. 11.1 Spatial composition of a view (Source: Okamura 2008. (Okamura 2013))

as a tower or castle, as well as deriving comfort from overlooking the whole city. Ashihara (1979) stated that increasing opportunities for overlooking the city in the urban landscape would make it attractive, while Higuchi (1981) explained that if locations commanding a fine view are turned into rest places and locations where one can rest are turned into viewing places, these improvements would increase our vitality (Fig. 11.1). Relatedly, Nishimura (1997) and Shibata et al. (2004) asserted that conserving an urban view encompassing its mega structure would be significant since geographical features have been definitely unchangeable.

11.1.2 The Four View Phases in Edo and Tokyo

View Research Group, in which the author once participated, published an article entitled "View Survey in Tokyo," indicating that a view comprises three parts – the foreground, background, and landmarks – and is also classified into three types: perspective, vista, and panorama. They also illustrated where typical examples of each were located and what spatial characteristics they possessed.

These views need to be comprehensively analyzed in terms of urban history and conservation, from Tokyo's former guise as Edo to the modern-day capital city. Even though they are visually similar, they have a variety of origins and histories: some were adopted from the Edo era, some were newly constructed in the process of urban design after the modern period, and others were created in developing a public space in recent years. Nowadays, furthermore, with Tokyo progressing both vertically and in density at a rapid rate, it has had more varied views, with some being visually affected while others have been protected under local authority legislation. In particular, local governments have been able to implement more effective measure to control building design and height since the Landscape Act was enacted in 2004.

Based on the above, this chapter establishes four phases – "foundation," "creation," "obscuration," and "conservation" – for views in Edo and Tokyo in the context of urban transformation, and illustrates characteristic events based on the author's previous research and a literature review. In particular, Sect. 11.4, considering "conservation" of views, demonstrates the recent trend with regard to a view management plan by examining the official landscape plans of local governments in Tokyo metropolitan area. Finally, Sect. 11.5 discusses how we should create and conserve a view in central Tokyo for the future.

11.2 Foundation for Views

This chapter specifically focuses on the distant or proximal landmarks that were used to identify axes for block planning in the town center of Edo, as well as several views incorporated in scenery spots, most of which can be verified by reference to old maps and images. Their existence reminds us that many views were naturally formed by utilizing major geographical features beyond the city boundary and minor undulation within it.

11.2.1 Road Layout Reflecting Axes for Mountains

As numerous castle towns had introduced, block planning in the center of Edo partially referred to visual axes towards Mt. Fuji or Mt. Tsukuba as outstanding landmarks. This urban design technique has been called "*Yamaate*" in Japanese. Kirishiki (1972) revealed that this landscape planning, encompassing distant landmarks, was adopted after completing landfill of Hibiya Irie (Estuary). Kirishiki also explained that the authority allowed buildings along high streets such as "Honcho dori" or "Nihonmbashi dori" to attach a 1-ken-wide eaves in front of those.

Furthermore, several small hills within the city, such as Atago-yama, Zojoji Temple, Yushima-dai, and Kanda-yama were identified as landmarks to determine axes for road layout in the center of Tokyo. As illustrated in Fig. 11.2, grid patterns are neatly spread, whilst moderate declination can also be observed. The latter was caused by each block having a specific landmark for orientation.

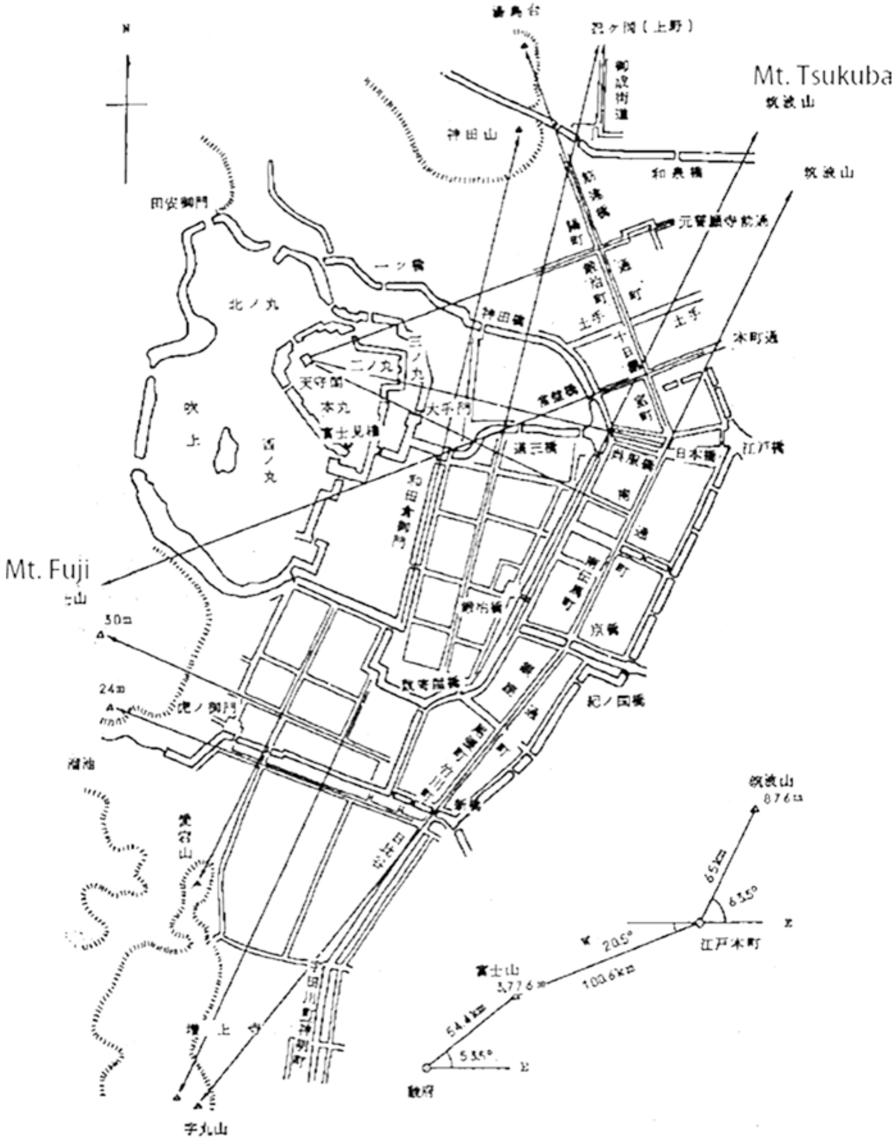

Fig. 11.2 View axes in central Edo in the period of Kan-ei and Shou-ou (Source: Kirishiki (1972)).

11.2.2 Views Incorporated Within a Scenery Spot

Several views in Edo can be reproduced by following visual materials depicting various scenic spots, some of which were published in a guidebook for tourists. Saito and Yajima (1987) identified typical landmarks in Edo and analyzed both the geographical distribution of viewing places and its spatial structure. Based on their findings, they identified that landmarks located outside Edo, such as Mt. Fuji, Mt. Tsukuba, and Mt. Kano (in Boso Peninsula), were viewed from these locations, the geographical structure of which matched the visual orientation. Conversely, they also established that there were several landmarks within the city standing at the edge of a hill, such as Kaneji Temple, Sensoji Temple, Edo Castle, Azuma Bridge, etc. Such monuments could be viewed even from distant spots. More recently, Chiba (1996) classified many overlooking views into several types: for example, from the edge of Musashino Plateau, some spots offered the combination of a distant view of Mt. Tsukuba or Boso Peninsula with the foreground of the central Edo roofscape. Alternatively, from the inside of Musashino Plateau, some spots could command a distant view towards Mt. Fuji alongside the short-distance view overlooking local neighborhoods.

11.3 Creation of Views

Edo was renamed Tokyo in 1868 due to the restoration of the Imperial power. Tokyo hoped to realize an urban space imitating Western cities and introduced ideas and techniques of town planning and urban design. Through this process, there appeared baroque-style urban design, in which some vistas for monumental structures, such as the Diet Building and Tokyo Station, were embedded into the existing urban fabric. Furthermore, new views were created when developing public spaces, utilizing existing views or existing monuments to reconstruct the spatial order in the chaotic city.

11.3.1 Creation of a Vista Based on Baroque-Style Urban Design

The Meiji Government, which formed after the Edo *Bakufu* (Japanese feudal government) was abolished, tried to introduce modern city planning, particularly pursuing baroque-style in terms of urban design; they pursued this objective principally by inviting foreign engineers to join the government service. This style became widely famous through Haussmann's central Paris redevelopment, where there are vistas emphasizing a perspective, symbolic townscape, with an eye-catching monument located in a central square, from which broad streets branch off, lined with trees or buildings. In Japan, it is assumed that it was first proposed in the "Government Offices Centralizing Plan," but it has never been realized. Meanwhile, several vistas have been gradually completed in central Tokyo, as Okamura et al. (2003) identified 12 cases, varying from those placed within the existing urban fabric, such as the Diet Building, Tokyo Station, Meiji Memorial Picture Gallery, etc., to those created within closed premises, such as the University of Tokyo, Waseda University, Ueno Park, etc. Moreover, Sasaki (1992) discussed that unlike in cities in the Western world, Japanese city vistas have simply been embedded independently, without recognizing their part in the whole urban structure. Additionally, Hirano and Shinohara (1992) highlighted the uniqueness of Japanese vistas with the viewed monument obscured by a tree placed in front of it, thus decreasing the effect of perspective.

11.3.2 Vista of the Diet Building

Normally, in not only Japanese but also Western cities, a vista's components –the viewing place, foreground, and landmark – are simultaneously formed. However, the vista of the Diet Building located, south west of the Imperial Palace, had a unique formation process (Figs. 11.3 and 11.4).

After plans for the building and its frontal and straight road were first proposed as part of the "Government Offices Centralizing Plan" in 1886 by German engineer Bockmann, the building was eventually completed in 1936. However, the road was not realized for many more years, despite numerous plans being proposed by architects and planners as opportunities arose for reconstruction after the Kanto Earthquake and World War II. Finally, this vista was completed in 1963, 1 year before the Tokyo Olympic Games.

11.3.3 Improvement of a Public Space by Utilizing an Existing View

Modern city planning in Tokyo has sought to create public parks and greenery space, open to everybody for use in recreation, disaster prevention, and for the sake of sanitary. This has led to the development of parks and squares that potentially provide great viewing spots. In Tamagawa Scenic Area, designated under the City Planning Act in 1933, the park was developed in 1953: as stated at the time of its designation, "this area can offer a great panorama consisting of Hakone Mountains and Mt. Fuji over the plateau of Kanagawa and Saitama when overlooking from the hill." It, therefore, is a place of scenic beauty where the public can savor the natural scenery. Similarly, Saigoyama Park was opened in 1981 as a public park offering a

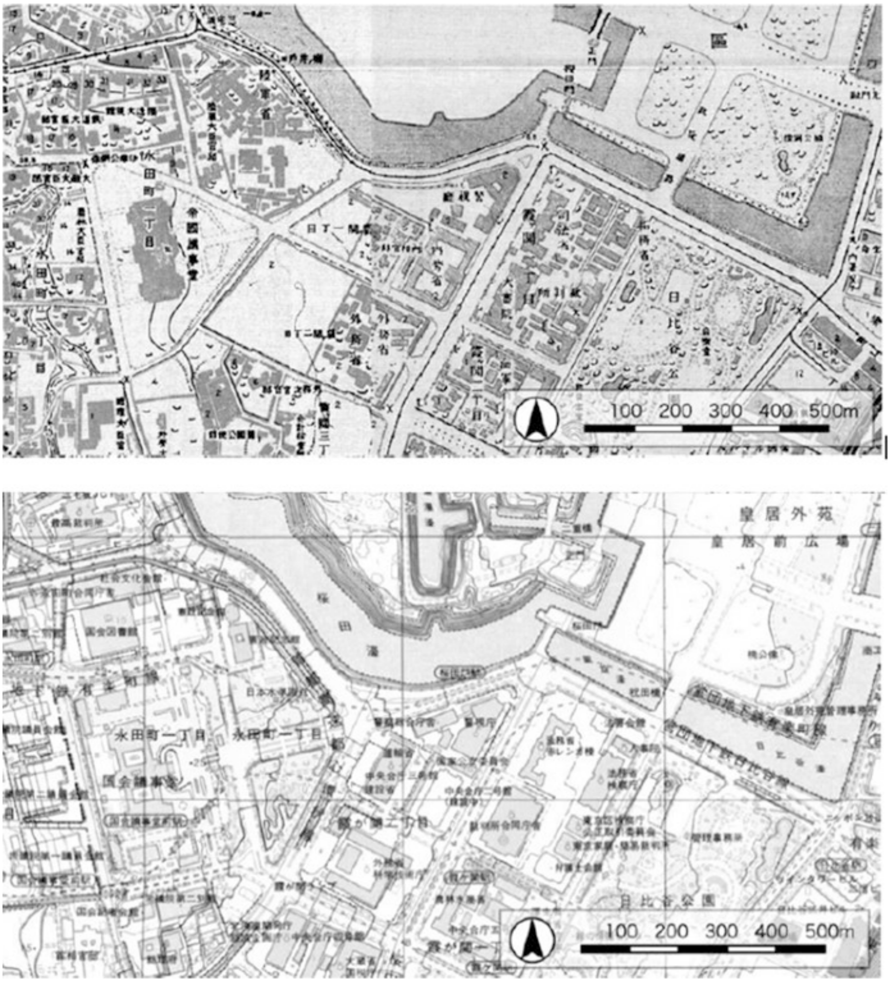

Fig. 11.3 Transformation of premises around the Diet Building (above:1937; below: 1999) (Okamura 2013) (Sources: above: Army Land Survey (1937) 1:10,000 topographical map of "Yotsuya," "Mita," "Nihonbashi," and "Shimbashi"; below: Geographical Survey Institute (1999) 1:10,000 topographical map of "Nihonbashi" and "Shinjuku" (in Japanese))

fine view of Mt. Fuji, making use of a geographical feature located at the southern edge of Yodobashi Plateau (Kano et al. 1998).

Other examples of the developments of public spaces incorporating an existing view or landmark were collected and analyzed by Nishimura and View Research Group (2004b). The pavement in front of Mita Kokusai Building was improved with tiles and trees to attract people's attention to Tokyo Tower (Fig. 11.5). Moreover, the main axis in West Promenade was deliberately designed to directly face Rainbow Bridge and Tokyo Tower, which are located far from this area. These cases were not products of chance, but rather the results of intentional spatial improvement.

Fig. 11.4 Vista of the diet building

11.4 Obscuration of Views

As stated above, views have been created in central Tokyo by means of urban design or landscape design, attracting visitors and residents as an urban axis or a fascinating resource. Meanwhile, Tokyo has become higher and denser since high economic growth in the 1960s, leading to views being obscured and views of landmarks being blocked or restricted by new buildings.

11.4.1 Obscuration of Foreground in a View

Usually, views whose foregrounds are secured by a road or a river, especially those vistas in which a viewing spot and landmark were integrally designed and created, are unlikely to be damaged by new buildings or structures. However, in some cases, such as the vista of Tokyo Station, redevelopments of sites along the axis road in the foreground have caused extraordinary changes.

Generally, a view such as a panorama or a perspective with a distant landmark tends to be blocked or obscured by tall buildings. This has often been the case with the Fujimi slopes, commanding a view of Mt. Fuji. Terakado et al. (1999) indicated that only one slope, named Nippori Fjimi Slope, could offer a complete view

Fig. 11.5 Examples of a view incorporating existing landmarks. Above: a view from Mita Kokusai Building to Tokyo Tower. Below: a view from West Promenade to Rainbow Bridge and Tokyo Tower

towards Mt. Fuji; the other 16 Fujimi slopes in very central Tokyo had their views unintentionally blocked by tall structures along the slope or on the main road in the foreground, with the development of such buildings permitted by legislation. Furthermore, Chiba (1996) compared Fujimi views between Edo and present-day Tokyo and concluded that their scales, in terms of both depth and width, had considerably diminished.

11.4.2 Obscuration of Background in a View

Tall structures have often disturbed the background of an orderly view, potentially spoiling its aesthetic and integrity, and thereby undermining its value. Such problems have particularly affected landscapes in traditional Japanese gardens and urban vistas.

Traditional Japanese gardens have been artificially disturbed by developments in their settings, and their skylines have been heavily damaged: for example, Tokyo Dome over Koishikawa Korakuen Gardens and Shiodome redevelopment area over Hamarikyu Gardens. Through case studies in historical gardens designated as a national property in Tokyo, Shinji et al. (1989) revealed that the intrusion of something odd in the setting of gardens caused disorder in the visual lines and foreignness between contemporary architecture and the garden's original components. Mukojima-Hyakkaen Gardens is an exceptional case, as it successfully avoided the construction of a tall building immediately adjacent to the garden with the owner expressing understanding (Murohoshi 1991). Narita (1999), whose study was conducted 10 years after the afore-cited Shinji et al. (1989), reported that the number of artificial structures disturbing views in the five traditional gardens had grown from 142 to 177.

Meanwhile, with regard to the background of vistas in central Tokyo, such famous monuments as the Diet Building, Tokyo Station, and Meiji Memorial Picture Gallery have all been disturbed by tall offices, residences, and hotels.

11.5 Conservation of Views

Whilst Tokyo's views were still confronted by the aforementioned threats, they gradually became targets for conservation. In this regard, the afore-cited Nishimura et al. (2004b) and Okamura et al. (2003) explained the recent efforts by local authorities. Before the Landscape Act was enacted, there were some conservation plans, which established restrictions in terms of building height, volume, and design; there were also numerous plans implying the existence of a view and its significance in the urban landscape. The Tokyo Metropolitan Government's "Urban Landscape Master Plan" insisted on consideration being given to views from a cliff line, those towards Mt. Fuji and Mt. Tsukuba, and those from bridges. Meanwhile, Chiyoda Ward's "Aesthetic Area Guideline" demonstrated the value of the vistas of Tokyo

Station and the Diet Building based on urban history. However, in practice, which was not an effective measure.

Following the enactment of the Landscape Act, Tokyo Metropolitan Government and each local ward undertook to establish a "view conservation plan" as a part of their Landscape Plan. This section overviews the state of art conservation methods.

11.5.1 Tokyo Metropolitan Government's "View Conservation Plan"

Established in 1997 and then amended in 2011, the Tokyo Metropolitan Government's Landscape Plan promotes necessary measures for conserving views from traditional gardens, deliberately designed vistas towards a monument, and scenery around the Imperial Palace. Regarding traditional gardens, "Special Landscape Creation Districts" with criteria specified by the Act have been established. Buildings over 20-meters-high within 100 m to 300 m of the boundary of the gardens are subject to control in terms of height and design (Fig. 11.6). Regarding vistas, the "Advance Consultation System" is applied where these will potentially be affected by large-scale developments under an incentive scheme enabling higher buildings. This requires developers to consult with the planning authority of the Tokyo Metropolitan Government in advance of the prescribed town planning procedure, with a view to controlling the landscape. Basically, buildings to which the standards within a "Landscape Control Area" apply are not permitted to exceed the threshold formed by a viewing spot and both ends of the landmark's base. As regards the surroundings of the Imperial Palace, especial viewing spots are identified and large scale developments are subject to control in terms of their visual impact from there.

In this Plan, historical views that have been developed under modernization, as well as views spread over multiple wards, are regarded as significant. Furthermore, the Plan can be evaluated as a key step towards view conservation through collaborating with the town planning system in central Tokyo, where development pressure is quite high. However, it does not impose express restrictions on building height, but rather offers guidance based on consultations.

11.5.2 Local Wards' "View Conservation Plans"

Local wards in the Tokyo metropolitan area have each launched their own landscape plan in turn, starting with Setagaya Ward; by March 2015, 17 local ward landscape plans had been established. From the perspective of conserving views, the policy and criteria based on each local landscape's characteristics are shown in the Plans. Specifically, local and unique views are listed, such as those taking advantage of a

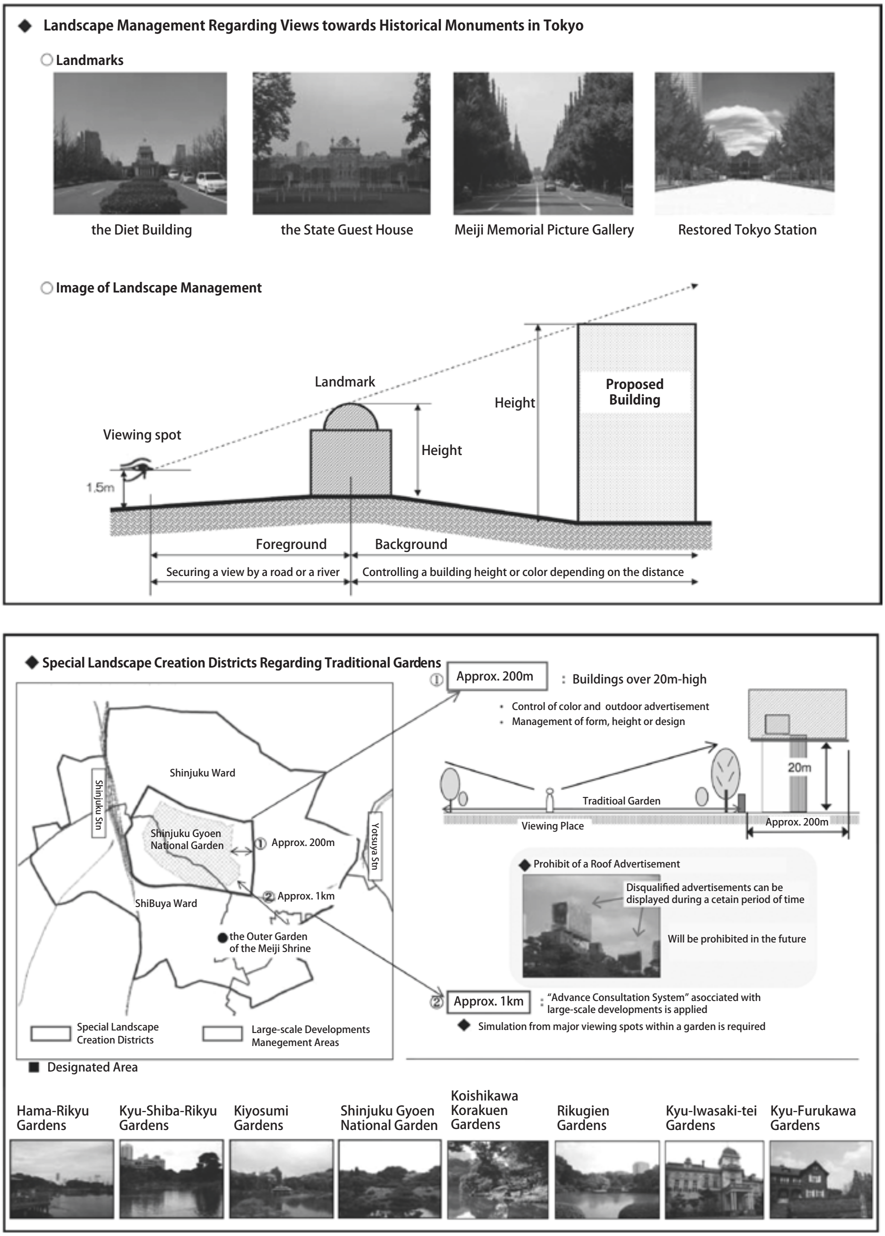

Fig. 11.6 Concept of view protection in Tokyo Landscape Plan. (Okamura 2013, translated into English) Above: landscape control on vistas symbolizing the capital. Below: Special Landscape Creation Districts Regarding Traditional Gardens (Source: Digest version of the Tokyo Landscape Plan)

geographical feature (e.g., the view from Tama Bank to Kokubunji Terrace (Setagaya Ward)), those along rivers (e.g., views along Shakujii River (Nerima Ward)), those towards an urban landmark (e.g. a view from Daimon Street to Daimon and Sangedatsu Gate (Minato Ward)), and those in gardens (e.g. views in the former Iwasaki Residence Park (Taito Ward). Despite recognizing these views as an important urban component, the criteria for conservation are still expressed qualitatively. Most are stated in the following (or equivalent) terms: "the scale of buildings must consider the visual impact on major viewing spots, such as river banks, a park or a bridge." Therefore, a theoretical grounding is needed in relation to what kind of building, in terms of height, scale, or design, either fits or does not disturb the future image.

Moreover, with regard to viewing spots, most cannot be identified as specific points, as they are still simply referred to as "important viewing spots" or "viewing places along the river." We need to devote more time to evaluating whether these statements are sufficiently effective in view conservation plans.

11.6 Conclusion

In closing this chapter, I wish to outline a future vision for creation and conservation of views in Tokyo.

First, as noted in Sect. 11.5, measures for conserving a view have become stabilized following the enactment of the Landscape Act, supplementing the earlier City Planning Act, including "Height Restriction Districts" and "Scenery Districts." However, we need to enhance planning theory and technique for the purpose of view conservation. Since, at present, qualitative criteria are rather dominant, we need to discuss and define "conformity" or "prominence," which are usually used to identify the goal. Furthermore, recognizing Sasaki's (2005) observation that Japanese landscapes are characterized by emphasizing the accumulation of components rather than the order of composition, it would be necessary to allow a certain amount of change in landscapes, instead of pursuing a fixed image. Therefore, it would be more significant to build a shared recognition for views. Meanwhile, with regard to a viewing spot or place, at the establishment stage of a plan, we need to conduct elaborative work to determine specific points. For instance, in London, as many as 33 points are identified along the River Thames and on the bridges that span it. Additionally, considering the special expanse of the area included many views, we need to promote collaboration between neighboring local authorities.

Second, as stated in Sects. 11.2 and 11.3, given that views have been embedded in the existing urban space over time, either with the city's reconstruction or the development of a public space in central Tokyo, we need to consider how new views can be created in the future. As one of the vital activities in this regard, when a road or square is newly developed, we need to carefully devise its location and configuration to encompass an existing urban landmark or road layout. These efforts could eventually lead to recovering the order of Tokyo's urban space.

Finally, to set a course for the creation and conservation of views, citizens need to share the value of views, recognize their necessity in their daily lives, and enjoy the extraordinary experiences offered by these views. These attitudes are definitely prerequisites for concrete measures. As the first step, it would be important to consider how we utilize views through a community-based movement. In Chigasaki City, located in a Tokyo neighborhood, a citizen's group launched the "Mt. Fuji Project" when confronted by a view of Mt. Fuji being diminished by the development of a tower block; they have engaged in several activities, such as a postcard competition, a workshop for children, and publishing a map illustrating the viewing road and square for Mt. Fuji, all for the purpose of publicizing the value of views of Mt. Fuji. The group was actually a driving force behind the opposition campaign against the development of a tall flat that would have potentially blocked the view of Mt. Fuji; they ultimately succeeded in stopping its construction (Okamura and Takamizawa 2009). As this example demonstrates, expanding the base for a view and increasing opportunities for viewing depend heavily on citizen support.

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Chapter 12
Transport Planning and Management in the Tokyo Metropolitan Region: Its History, Current Situation, and Future Perspectives

Tetsuo Shimizu

Abstract This chapter aims to explore the history of transport system development, travel and freight demand characteristics, and issues in future transport planning in the Tokyo metropolitan region. According to in the 5th Tokyo Person Trip Survey, conducted in 2008, the average daily number of trips is 2.45, and this has not changed over the last two decades. The railway's modal share has increased, while that of private cars has decreased in the last decade. Based on the Freight Flow Survey in 2013, 2.85 million tons of freight was moved in the Tokyo metropolitan region each day. The unique characteristics of the region's urban railway system are that many private companies have constructed and operated, and that the through operation among several routes has been introduced widely. Regarding roads, the Tokyo Metropolitan Expressway is a unique infrastructure, the likes of which are seldom seen in most of the world's cities in the world. On the contrary, Tokyo's airport and seaport systems have less uniqueness and competitiveness compared with major airport and port systems in the East Asia region. The basic transport infrastructures of road, railway, airport, and seaport in the Tokyo metropolitan region have almost been completed, pursuant to a series of intensive transport infrastructure planning, with the objective of assisting economic growth. Looking to the future, the basic direction of the region's transport planning in the coming decades will be developing a better management system to secure high utilization of the present transport infrastructures. Some of related planning issues are highlighted based on the future socioeconomic perspective of the region.

Keywords Transport planning · Transport system · Travel demand · Tokyo Metropolitan Region

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12.1 Introduction

In Japan, the Person Trip (PT) Survey has been conducted in major urban areas every 10 years, in order to investigate various aspects of travel behavior for commuting, business, shopping purposes, etc. In the Tokyo metropolitan region, comprising five prefectures – Tokyo, Kanagawa, Saitama, Chiba, and Southern Ibaraki – five PTs have already been conducted; the latest, “Tokyo PT5,” was conducted in 2008. As explored later, the major findings of Tokyo PT5 were that the daily number of trips per capita by elderly people had dramatically increased, while the number of car trips in the region had decreased for the first time. These findings indicate that current socioeconomic situations, such as the low birth rate, aging population, global warming, energy security, and economic stagnation, deeply affect travel behaviors.

Major transport infrastructure development projects in the region, which were illustrated until the 1990s, will be almost completed within 10 years. In particular, the forthcoming Tokyo Olympic and Paralympic Games in 2020 will intensively drive the completion of these projects. After their completion, future transport planning in the region may target more soft policy measures, aiming to maximize the efficiency of transport infrastructure.

In transport planning and management, we need to seek the balance between demand and supply. Therefore, the region’s transport planning and management efforts should be evaluated in terms of both demand and supply aspects. Therefore, this chapter’s objectives are to exhaustively summarize the characteristics of travel demand and the planning and development of the region’s transport infrastructure, from a historic perspective, and to discuss future perspectives on the region’s transport planning and management.

In Sect. 12.2, major characteristics of the region’s current travel demand are summarized. In Sect. 12.3, the history of transport infrastructure developments and services in the region is summarized. Finally, in Sect. 12.4, major challenges regarding the maintenance, improvement, and use of the region’s transport infrastructure over the coming decades are discussed, based on the expected socioeconomic situation of the region.

A transport system comprises three components: “way,” “terminal,” and “vehicle.” In this chapter, the former two, as infrastructure systems, are the main focus. Regarding the infrastructure systems, the road and rail systems are considered in detail, while airports and sea ports are only lightly considered. Regarding travel demand, passenger travel demand is highlighted more than freight demand due to data availability.

12.2 Characteristics of Recent Travel Demand in the Tokyo Metropolitan Region

12.2.1 Travel Demand Characteristics

As noted in the preceding section, the region's travel demand characteristics can be understood by the Tokyo PT5 conducted in 2008. Its basic data can be downloaded from the official webpage of the Tokyo Metropolitan Transportation Planning Council, and its major findings have already been reported through newsletters and research reports[1]. Therefore, in this chapter, only the basic characteristics will be considered, with some figures.

The average daily number of trips per capita was 2.45. The maximum number of 2.56 was observed in the 23 wards of Tokyo, while the minimum of 2.28 was recorded in the East Chiba area. Such differences may be explained by of the large number of business and private matter trips in the 23 wards of Tokyo. The average daily number of trips per capita in the last two PTs (PT4 in 1998 and PT3 in 1988) were both around 2.4, and this value has been almost fixed for the last two decades.

The average daily number of trips per capita by males was 2.49, slightly larger than that for females (2.41). Figure 12.1 shows the average daily number of trips per capita by age class. Within the productive age category, the 35–44 age group recorded the largest number (2.73), which tended to reduce both toward younger and elder age classes. Females aged 15–49 seem more active than males, having a larger average of daily number of trips per capita. On the contrary, females aged 50 and over seem much more inactive than males in the same age group. Figure 12.2

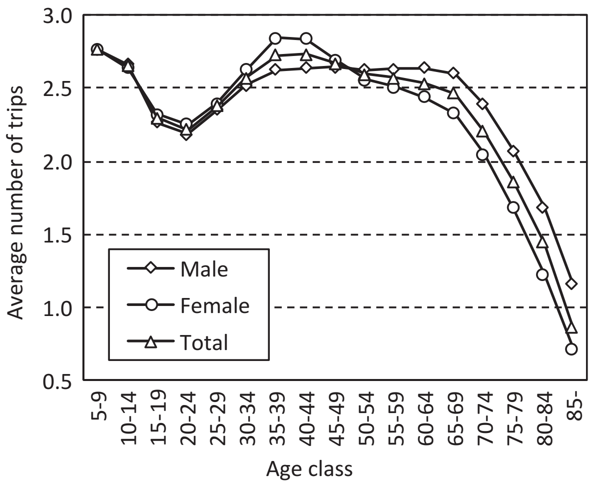

Fig. 12.1 Average number of trips by age class in the fifth Tokyo metropolitan region person trop survey in 2008 (Shimizu 2014)

[1] Refer to the webpage of the Tokyo Metropolitan Transportation Planning Council, https://www.tokyo-pt.jp/ (accessed 13 August 2016).

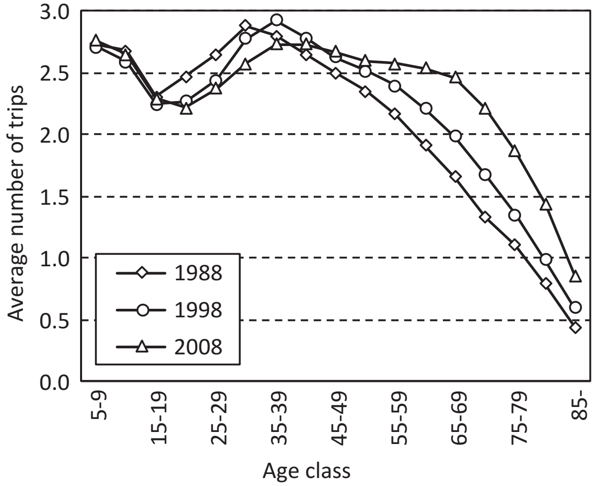

Fig. 12.2 Average number of trips by age class in the Tokyo metropolitan region person trip surveys in 1988, 1998 and 2008 (Shimizu 2014)

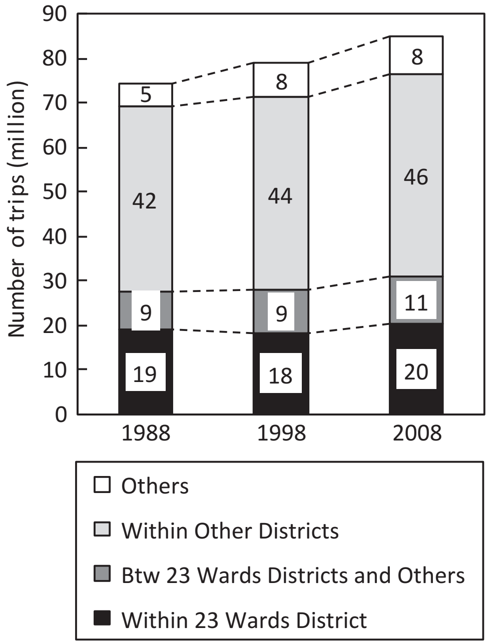

Fig. 12.3 Number of trips by OD pattern in the Tokyo metropolitan region person trip surveys in 1988, 1998 and 2008 (Shimizu 2014)

shows the average daily number of trips per capita by age class in the PT3, PT4, and PT5. It seems obvious that elderly people have made an increasing number of trips over the past two decades.

Figure 12.3 shows the Origin-Destination (OD) patterns in the PT3, PT4 and PT5. Around 85 million trips were observed in 2008, with 20 million trips entirely

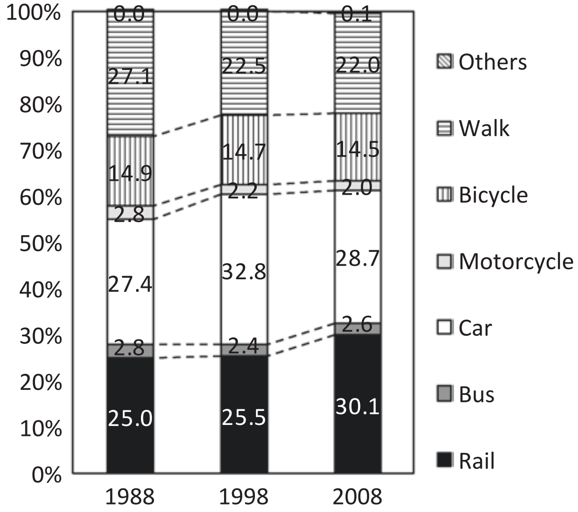

Fig. 12.4 Modal share in the Tokyo metropolitan region person trip surveys in 1988, 1998 and 2008 (Shimizu 2014)

within the 23 wards of Tokyo, and 11 million trips between the 23 wards of Tokyo and other areas (or the converse) (Tama area = 2.2 million, Kanagawa Prefecture = 3.1 million, Saitama Prefecture = 2.9 million, Chiba Prefecture = 2.4 million, and south of Ibaraki Prefecture = 0.2 million); thus, 36.5% of the total number of trips were generated or attracted by the 23 wards of Tokyo.

Figure 12.4 shows transport modal share in the PT3, PT4 and PT5. It is clear that the share of "walking" reduced, while the share of "car" increased from 1988 to 1998 due to population migration to suburban areas, caused by the radical increase in housing costs in central Tokyo and urban centers, together with successive motorization associated with this demographic shift. It is also understood that, subsequently, the share of "car" reduced while the share of "rail" increased from 1998 to 2008, due to reversed population migration to central Tokyo and urban centers close to railway stations, along with a reduction in car ownership and use associated with this demographic shift.

Here, we check the modal shares of "rail" and "car" by trip generating area in Fig. 12.5 The major features are that "rail's" share has been increasing in all areas over the last two decades, with a larger share of "rail" being observed in such areas as the 23 wards of Tokyo, Kawasaki City, and Yokohama City, located within commuting distance of Tokyo; while the modal share of "car" was small in those areas, it was large in such areas as East Chiba and South Ibaraki, which are beyond commuting distance of Tokyo.

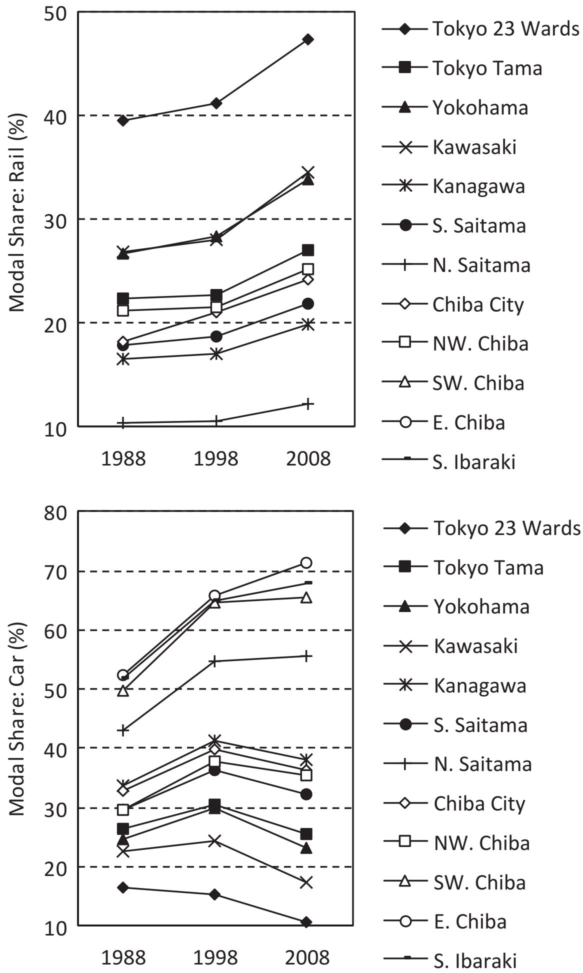

Fig. 12.5 Modal share by region in the Tokyo metropolitan region person trip surveys in 1988, 1998 and 2008 (Top: Rail, Bottom: Car) (Shimizu 2014)

12.2.2 Freight Demand Characteristics

The freight demand in the Tokyo metropolitan region is surveyed every 10 years by the Freight Flow Survey, which aims to understand the OD pattern and traffic flow of goods and trucks. The most recent (fifth) survey was conducted in 2013. Its basic data can be also downloaded from the official webpage of the Tokyo Metropolitan Transportation Planning Council.

In the fifth Freight Flow Survey, a total of 2.85 million tons of goods were transported in the region daily, and 1.02 million tons (36%) were transported within the region. Each day, 197,000 tons were generated in the 23 wards of Tokyo and 259,000 tons were attracted to the same area; thus, 12.7% of goods, on a weight basis, were transported in the area. Further, the daily number of trucks in the region was 682,000 and that within the region was 357,000 (52%). These results suggest that large trucks were used for transport between the Tokyo metropolitan region and other regions and vice versa.

12.3 Characteristics of Transport Infrastructure Developments and Services in the Tokyo Metropolitan Region

12.3.1 Urban Railway Network

The Tokyo Metropolitan Region already has a world-leading dense urban railway network. In total, 13 subway routes are operated, and these routes welcome the world's largest number of daily passengers, at around nine million[2]. The commuter railway routes connecting central Tokyo with suburban areas have also been developed radially. The total railway network length in the 23 wards of Tokyo is around 700 km. The railway network density is 1.11 km/km^2,[3] which almost matches those in major Asian and Western mega-cities. On the other hand, the railway network length in the Tokyo PT5 area (around 16,000 km^2) is approximately 4200 km, and its density is 0.26 km/km^2,[4] which is larger than the 0.18 km/km^2,[4] of the "Ile-de-France" Region, including Paris (Metro, RER, and Transilien) and the 0.05 km/km^2,[5] of Seoul-Incheon-Gyeonggido Region. Therefore, the railway network density of the Tokyo Metropolitan Region may be the largest among the world's urban regions with an urban railway network.

The uniqueness of Tokyo's urban railway system is that many private companies own and operate it. Vertical separation has been introduced to local transport businesses across the world over the last two decades. Under this scheme, an infrastructure holding organization which is mostly owned by public sector, owns and maintains railway infrastructure, and leases the infrastructure to operating companies. The advantage of this scheme is that the railway business becomes more competitive by reducing the initial infrastructure development cost. On the contrary, Tokyo's railway service has been provided through private investment because: (1) most private railway companies are responsible for limited routes in densely developed urban areas; (2) many private railway companies have developed residential areas alongside routes themselves in order to secure profit from their

[2] The author calculates using the data shown in the official webpages of two subway operators, the Tokyo Metro Company and the Bureau of Transportation of the Tokyo Metropolitan Government.

[3] The author calculates using the route length date shown in the official webpages of railway operators. The network length in the Tokyo Metropolitan Region by East Japan Railway Company is calculated using the route length data in the Wikipedia.

[4] The author uses the same method as the note 3.

[5] The author calculates using the route length date shown in the official webpages of railway operators.

railway business; and (3) the route development was (fortunately) completed before motorization (Ieda 2008).

Tokyo's first urban railway plan was released in 1925. After the war, the second plan was released in 1946, following which a further seven plans have been released, at a rate of one every 10–15 years. In the plans up to 1972, the subway network extension was the major issue, whereas in the last three plans (1985, 2000, and 2016), special attention has been given to network extension in suburban areas. The history of these plans and their missions have already been surveyed by Kimishima (1983), Yasoshima (1986), and the Research Group on Railway Network Development in Tokyo (2000). According to these studies, the concepts of Tokyo's urban railway network planning can be summarized as follows:

1. Realistic, rather than idealistic, planning in order to cope with a radical increase in travel demand.
2. Network planning to support the change of urban form (including the development of new urban centers, such as Shibuya, Shinjuku and Ikebukuro, and new town developments such as Tama, Kohoku and Chiba) and the extension of the Metropolitan Region.
3. Strong attention to developments of missing links and connecting routes.

For example, world-famous through-train services, via which suburban commuter rail routes are connected via the subway route, have been introduced over several decades based on the above objectives.

The rising in-vehicle congestion level associated with the radical demand increase has been a major policy concern regarding the railway for several decades. Therefore, a reduction in the ridership-capacity ratio has been the principal policy target in Tokyo's urban railway planning. As shown in Fig. 12.6, the average ridership-capacity ratio in peak hours was 221% in 1975; however, it was reduced to 165% in 2014 through various endeavors in network extension and service improvement. The latest urban railway plan released in 2016 sets targets for 2030: the target ridership-capacity ratio has been set at 150%.

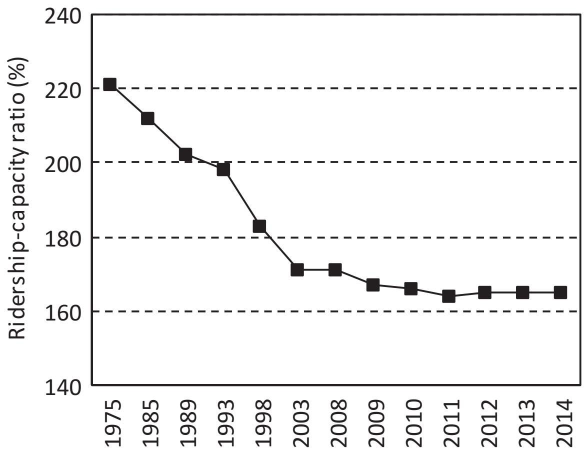

Fig. 12.6 Changes of ridership-capacity ratio at peak hours in the Tokyo Metropolitan railway network (drawn up by the author using the data published by the Railway Bureau of the Ministry of Land, Infrastructure, Transport and Tourism, Japan) (Shimizu 2014)

In the 2016 plan, 24 new routes were listed as a future development project to increase urban competitiveness and/or to support regional development. The most epoch-making issue of the latest plan is the proposed station upgrade and renovation policy: the first time such proposals have been included these plans. These facts suggest that the focus of railway policy and planning in the Tokyo Metropolitan Region has gradually shifted from route development to connection links and node developments.

12.3.2 Bus and Taxi Services

Due to the larger contribution of urban railway services, bus services have been less competitive and effective in the Tokyo Metropolitan Region. In the Tokyo prefectural area, public buses operated by the Tokyo Metropolitan Government and 12 private bus operators provide transport services. Some are affiliated companies of railway companies, and the service networks provided by these companies are, therefore, well connected to railway routes. The annual ridership of bus services in the Tokyo Metropolitan Region peaked at 2.55 billion in 1970, since when it has gradually declined by 40% to 1.59 billion in 2008 (Nihon Bus Association 2012).

In total, 476 taxi companies provide around 50,000 taxi vehicles in the Tokyo prefectural area; consequently, there are lots of small companies in this industry. Following the introduction of Japan's public transport deregulation policy in 2002, the number of taxi vehicles increased. However, the load factor and revenue per vehicle have been reduced, thereby worsening the labor condition of taxi drivers. Since regulations on supply-demand adjustment were implemented again in 2008, the number of taxi vehicles has been reduced (Tokyo Hire-Taxi Association 2012).

12.3.3 Road Network

The shape of the trunk road network in the Tokyo Metropolitan Region is classified as radial and circular. Eight major national roads connect central Tokyo and regional hub cities, and eight ring roads have been planned or developed. The total length of the road network in the Tokyo prefectural area was around 24,500 km in 2015, with a total road-surface area of 186 km^2 and a road-area ratio of 8.5% (rising to 16.4% in the 23 wards of Tokyo)[6]. The road-area ratio of Tokyo is thus, smaller than that of Paris or New York (25%), as reported by Hanaoka and Acharya (2008). Moreover,

[6] Refer to the webpage of the Bureau of Construction, Tokyo Metropolitan Government, http://www.kensetsu.metro.tokyo.jp/jigyo/road/kanri/index.html (accessed August 13, 2016).

that of the Tokyo Metropolitan Region in 2013 (excluding South Ibaraki) is 5.8%[7], based on a total road-surface area of 787 km^2.

Fujimori (2004) and Koshizawa (2001) previously examined the history of road network development in the Tokyo Metropolitan Region in the Meiji (started in 1868), Taisho, and early Showa (before 1945) eras. The city of Edo, the former name of Tokyo, was developed as a castle city. Edo Castle occupied the central zone that was converted to the Imperial Palace. On the terrace of the north and west sides of Edo Castle, "*Daimyo*" (Japanese regional lords) developed their houses on large and irregularly-shaped land lots. On the contrary, on the Castle's east side, on the lowland, merchants lived in smaller and grid-shaped land lots. Buildings were highly combustible, and suffered devastating fires. The Meiji government created Tokyo's fist road network development plan, named the Ginza brick-building street plan, in 1872, aiming to prevent substantial fires, to accommodate horse-cart-based motorization, and to realize sustainable urban growth. The first modern city planning for Tokyo was proposed in 1884 with the same objectives, but on finalization in 1903, its size was downscaled due to lack of funding and changed policy initiatives. Following the dramatic destruction inflicted by the Great Kanto Earthquake in 1923, the east side of Tokyo, bridges on the Sumida River, and some high streets, such as Showa-dori Street and Meiji-dori Street, were developed by the Tokyo Reconstruction Plan. However, this plan was dramatically downscaled due to the lack of funds and strong resistance by land owners.

After the war ended in 1945, the major Japanese cities implemented their war reconstruction plan. Horie (1989) has previously summarized the background and the philosophy of the Tokyo War Reconstruction Plan, directed by city planner Eiyo Ishikawa. The epoch-making features of the plan, in terms of road network development, were the development plans for eight ring roads and high streets of 80 m to 100 m width; however, this plan was also downscaled due to lack of funding caused by the monetary tightening policy named "Dodge Line," along with the lack of political leadership. Relatedly, the rapid economic growth during the 1950s and1960s demanded radial road, rather than ring road, development in order to establish strong connections between Tokyo and regional cities. When radial road development had been almost completed and the importance of ring road development was noticed, central Tokyo had already been densely urbanized and it became difficult to develop the planned ring road sections.

In the aforementioned rapid economic growth period, Tokyo's roads became heavily congested due to rapid motorization and the insufficiency of the road network. Furthermore, with Tokyo scheduled to host its first Olympic Games in summer 1964, more severe congestion was expected. The Metropolitan Expressway (MEX) was proposed to cope with these problems. Horie (1996) and Furukawa (2008) have previously summarized the background and the philosophy of the

[7] The author calculates using the road surface area data of the Tokyo Metropolitan, Kanagawa Prefecture, Saitama Prefecture, and Chiba Prefecture in the road statistics 2015 issued by the Japanese Ministry of Land, Infrastructure, Transport and Tourism, http://www.mlit.go.jp/road/ir/ir-data/tokei-nen/2015/pdf/d_genkyou04.pdf (Accessed 13 August 2016)

network. The underlying concept of the MEX is to develop a network without traffic signals by connecting access-controlled road sections, flyovers, or underpasses at intersections. This unique expressway network opened its first route in 1962, and its length now exceeds 300 km. The daily traffic volume is around one million vehicles, and it covers 4%[8] of the total travel demand in the PT5 area. At present, the MEX is continuing its network extension in Yokohama City.

On the contrary, the expressway network in the Tokyo Metropolitan Region still lacks circular sections, and their development has been an ongoing issue for decades. Construction of the first ring, named the Central Circular Route of the MEX, was completed in 2015, while, the second, ring named Tokyo Gaikan Expressway, and the third ring, named Ken-o Expressway, are still in the construction and planning stages respectively. In 2016, completion rate of the second and third rings reached 74%[9] in 2016. This progress is very slow compared to that on similar projects in other mega-cities, such as Seoul, Beijing, London, and Berlin, where ring expressway route development have almost been completed.

Typical indexes for evaluating the effect of road development are congestion length and the number of fatal and injury accidents. Figure 12.7 shows the trend of average congestion length in an hour on weekdays in the Tokyo prefectural area,

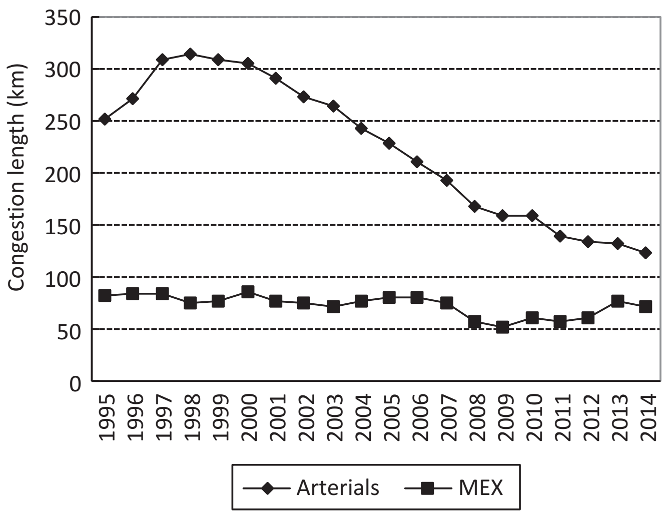

Fig. 12.7 Changes in road congestion in Tokyo (drawn up by the author using the data published by the Metropolitan Police Department, Japan) (Shimizu 2014)

[8] Calculated by the author using the daily traffic volume on the official MEX webpage, the number of MEX users in the report of the 25th MEX Traffic and OD survey, and the number of car trips in the Tokyo PT5.

[9] Refer to the webpage of the Kanto Regional Development Bureau of the Japanese Ministry of Land, Infrastructure, Transport and Tourism. http://www.ktr.mlit.go.jp/ honkyoku/road/3kanjo/international/foreign.htm (accessed August 13, 2016).

including 2406 km of arterial road sections and 377 km of MEX sections. In the last 15 years, both values have gradually reduced. This tendency can be explained by the effect of road network development, as well as the decreased car use noted in the previous section and recent economic stagnation. Although many political efforts toward economic revival have been contemplated, these may have less effect on the increase in traffic congestion than expected.

12.3.4 Airport

Since the opening of Narita Airport in 1978, Haneda Airport has principally been used for domestic demand and Narita Airport for international demand, based on the aviation policy for the Tokyo Metropolitan Region. The annual number of passengers at Haneda Airport was around 69 million[10] in 2013, ranked the fourth largest globally, while that at Narita Airport in 2013 was around 35 million[11].

The Japanese domestic aviation network has been mainly formed by the connections between Haneda Airport and local airports; however, the capacity restraint of Haneda Airport has been a key barrier to network development. Haneda Airport began operating with two runways after the war, and its third runway was opened in 1997 pursuant to the first offshore expansion project; its fourth runway was later opened in 2010, following completion of the second offshore expansion project. Furthermore, three terminal buildings – Terminal 1, Terminal 2, and the International Terminal – were opened in 1993, 2004, and 2010, respectively. After the opening of the fourth runway, the annual number of arrival and departure slots increased from 303,000 to 447,000[12].

On the contrary, Narita Airport has been struggling to expand its capacity. The original plan was for Narita Airport to have three runways; however, it started operating with only one runway due to a strong opposition movement coordinated by local residents. The second runway tentatively opened in 2002 for the FIFA World Cup, and it was expanded in 2009; meanwhile, the third runway is still in the planning stage. Terminal 2 was opened in 1992, while Terminal 1 was renovated and re-opened in 2007.

The supply-demand adjustment policy in the Japanese aviation market was abolished in 2000. This allowed the entry of new airline companies, and the additional arrival and departure slots at Haneda Airport have been advantageously assigned to these entering companies. Following the expansion of Haneda Airport,

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[10] Refer to the webpage of the Airport Council International, http://www.aci.aero/Data-Centre/Annual-Traffic-Data/Passengers/2013-final (accessed August 13, 2016).

[11] Refer to the webpage of the Narita International Airport Corporation, http://www.naa.jp/jp/airport/pdf/unyou/y_20140327_2.pdf (accessed August 13, 2016).

[12] Refer to the webpage of the Civil Aviation Bureau of the Japanese Ministry of Land, Infrastructure, Transport and Tourism, http://www.mlit.go.jp/common/001081144.pdf (accessed August 13, 2016).

the role-sharing policy for Haneda and Narita Airports has been gradually reconsidered, with 90,000 slots now assigned to international flights at Haneda Airport.

Low-cost carrier (LCC) services have become popular in the United States, European counties, and Southeast Asian countries since the 1990s. This concept finally reached Japan in 2012, when three Japanese LCC companies began operating in the country. Two companies locate their domestic flight services mainly at Narita Airport. Terminal 3, dedicated to LCCs, was opened in 2015 to facilitate LCC businesses; subsequently, the annual number of arrival and departure slots at Narita Airport in total increased from 220,000 to 300,000.

Despite the aforementioned airport expansion efforts, the positions of Narita and Haneda Airports as hub airports in the international aviation market have been threatened by the opening of large airports in neighboring Asian countries, such as Incheon (South Korea), Beijing Capital (China), Shanghai Pudong (China), and Hong Kong.

12.3.5 Sea Port

In Tokyo Bay, there are four Special Major Ports – Tokyo, Yokohama, Kawasaki, and Chiba – and two Major Ports: Kisarazu and Yokosuka. According to the 2014 Port Survey[13] conducted by Japan's Ministry of Land, Infrastructure, Transport and Tourism of Japan, the cargo volume of Chiba Port was 163 million tons, ranked the second largest in Japan, and that of Yokohama was 117 million tons, ranked third. In total, the Cargo volume of six ports covered 19% of the total demand in Japan, and half of the volume was for imports.

A container transport system was introduced several decades ago for international trading, except of raw materials, grain, and energy source materials. The share of container transport in all Japanese ports in value terms is larger than that on a weight basis of about 20%. In general, a port's direct connection to international regular service networks is crucial for the economic growth of its hinterland, as many of the shipped containers are normally transported on such networks. In Japan, the Port of Tokyo is the largest port in terms of container volumes, at 4.89 million TEU (Twenty-foot Equivalent Unit) in 2014, while the Port of Yokohama (2.88 million TEU) is the second largest, followed by the six major ports in Tokyo Bay, which handle around 40% of total container volumes in Japan[14]. However, the Northeast Asia region already has 11 mega-ports that handle more than 10 million TEU annually, while the Port of Tokyo ranked 28th globally in terms of container

[13] Refer to the webpage of the Ports and Harbours Bureau of the Japanese Ministry of Land, Infrastructure, Transport and Tourism, http://www.mlit.go.jp/k-toukei/saisintoukei.html (accessed August 13, 2016).

[14] Refer to the webpage of the Ports and Harbours Bureau of the Japanese Ministry of Land, Infrastructure, Transport and Tourism. http://www.mlit.go.jp/common/000228235.pdf (accessed August 13, 2016).

volumes[15]. Thus, Japanese ports have already lost their international status in the container transport system.

12.4 Future Perspectives on Transport Planning and Management in the Tokyo Metropolitan Region

12.4.1 Basic Direction, Considering Expected Socioeconomic Circumstances and Technical Innovation

Needless to say, a huge amount of time, cost, and work is needed for the further development of Tokyo's urban transport system. Based on the previous sections, urban planners and related authorities have presented ambitious visions for transport planning in the Tokyo Metropolitan Region for more than 150 years; however, the final plans have often been trivialized compared to such grand designs, and their implementations have often been scaled back or minimized, due to the lack of available funding, space, and/or political passion. The main features of transport planning in the Tokyo Metropolitan Region during the Meiji, Taisho and Showa eras were efforts to increase capacity to cope with a radical travel demand increase. Due to these efforts, major transport system developments in the Tokyo Metropolitan Region, at least in terms of quantity, have already been completed. Conversely, the quality of the system has received less attention. Inevitably, therefore, the main issues for future transport plans to address are how the system can meet various kinds of citizens' needs and how it can increase their quality of life.

According to the estimation of the National Institute of Population and Social Security Research, Japan[16], the population of the Tokyo Metropolitan Region will start decreasing in 2020, before which the population of its surrounding prefectures will also start decreasing. The proportion of the population aged 75 years and over is expected to reach 17% in the Tokyo Metropolitan in 2040. Consequently, the system will face the challenges of an increasing number of people who cannot move by themselves, as well as the likely decrease in funding for transport planning and management works. The region is already confronted by the urgent issue of transport infrastructure deterioration, particularly of infrastructures developed during the period of high economic growth in 1960s and 1970s, such as some sections of the MEX. Another important issue is how to make the infrastructure more resilient to disasters such as earthquakes.

Of course, other growth in the travel demand, such as that of foreign tourists, can be expected in the Tokyo Metropolitan Region. The number of foreign tourists

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[15] Refer to the webpage of the Ports and Harbours Bureau of the Japanese Ministry of Land, Infrastructure, Transport and Tourism. http://www.mlit.go.jp/common/000228237.pdf (accessed August 13, 2016).

[16] Refer to the webpage of the National Institute of Population and Social Security Research, Japan, http://www.ipss.go.jp/pp-shicyoson/j/shicyoson13/t-page.asp (accessed August 13, 2016).

exceeded ten million for the first time in 2013, before reaching almost 24 million in 2016. It is expected that the number will increase radically due to the visa abolition policy and successive economic growth in surrounding countries. In the Tokyo Metropolitan Region, it is expected that the Tokyo Olympic and Paralympic Games 2020, as well as the MICE (Meeting, Incentive, Conference and Exhibition) policy, will accelerate such increases.

Hereafter, with regard to future transport planning and management in the Tokyo Metropolitan Region toward 2035, and based on several ongoing and completed projects in which the author participates, several important issues will be raised based on the following key assumptions:

1. the real gross regional product per capita will not change for the next two decades, and
2. the number of trips per capita will not change for the next two decades.

Furthermore, we need to carefully consider potential technological innovations in the field of autonomous vehicles and environmentally-friendly vehicles in formulating transport planning and management frameworks for the next 20 years.

Autonomous vehicles may dramatically improve the self-mobility condition for people with limited mobility. In concrete terms, those aged 75 and over who have less ability in driving a car will also be able to move by themselves if level-four autonomous vehicles become available. Automobile companies and ICT companies have been researching autonomous vehicle in recent decades, and governments have, more recently, started to discuss the social and legal implications. In the interim report on autonomous vehicles by the Japanese Ministry of Land, Infrastructure, Transport and Tourism, published in 2013 (Committee on Auto-pilot System 2013), the roadmap toward perfect automated driving on expressway sections up to 2030 was set out; however, automated driving on urban streets was out of scope. Therefore, we possibly do not need to consider the dominance of autonomous vehicles on the urban road network, except for the expressway. Consequently, the effect of those vehicles on the dramatic increase of mobility conditions for mobility-impaired individuals is unlikely to be significant in the next two decades.

In this chapter, "environmentally-friendly vehicle" simply means an electric vehicle (EV) or fuel cell vehicle (FCV). Sperling et al. (2004) compared energy consumption per passenger kilometer for private motorized transport means and population density in various cities; they concluded that these indexes are inversely related. This finding suggests that a rail transit system, such as a commuter railway system and light rail transit system, is possibly sustainable and reduces the use of private cars in cities with higher population density. Calthorpe (1993) proposed the concept of Transit Oriented Development (TOD), in which higher population density zones introduced along public transport corridors in a city masterplan, reduce the ownership and use of private cars. Based on the supposition of conventional vehicles with an internal-combustion engine, reduced energy consumption in the transport sector and lower greenhouse gas emissions would be expected through implementation of a TOD policy. Alternatively, replacing conventional vehicles with EVs and FCVs may provide another route to reducing energy consumption and greenhouse gas emissions.

Dincer (2010) conducted a total cost analysis on environmentally-friendly vehicles, including EV and FCV. EVs were found to have advantages on fuel cost, greenhouse gas emissions, and air pollutant emissions, while their disadvantages concerned vehicle cost and cruising distance. FCVs were found to have no advantage over EVs except in cruising distance. In the case of electric power generation using fossil fuels, EVs loses their advantages in greenhouse gas and air pollutant emissions. The proportion of electricity generated by nuclear power plants in Japan has decreased due to growing concerns among citizens following the Fukushima accident in 2011. In these circumstances, the promotion of EVs may not be a competitive policy option. The diffusion of FCVs also requires a dramatic reduction in vehicle cost and the intensive development of hydrogen stations. Consequently, environmentally friendly vehicles will remain a minor feature on Tokyo's roads in the next decade, and policy initiatives on reducing car use are still required to mitigate the environmental load.

12.4.2 Increased Accessibility to Public Transport Systems at Railway Stations

Promotion of the use of public transport systems is inevitable to tackle the aging society and achieve energy saving. Furthermore, we should take into account the potential removal of road sections with smaller social value in the Tokyo Metropolitan Region, as funding for road maintenance will likely decrease in association with tax revenue reduction in the depopulating society. Consequently, public transport systems should be more enriched. As noted in an earlier section, the development the of railway network in the Tokyo Metropolitan Region is almost complete; however, more effort is needed to improve the quality of station facilities, including station plazas. The introduction of barrier-free facilities in and around stations may be a priority target in the next railway development and management plan for Japan's aging society.

The Japanese national government implemented the Barrier-free Law in 2006, which prescribes the transport operators responsibility for smooth transport and requests local governments to formulate a barrier-free master plan. According to the report by the Japanese Ministry of Land, Infrastructure, Transport and Tourism, 288 municipalities had implemented their master plan as of March 2016[17]. By heading barrier-free master plan development in several municipalities, the author came to realize is the inherent difficulty in expecting private transport operators to bear the

[17] Refer to the webpage of the Policy Bureau of the Japanese Ministry of Land, Infrastructure, Transport and Tourism, http://www.mlit.go.jp/common/001133666. pdf (Accessed 13 August 2016)

expense of facility development without revenue increases. An appropriate subsidy framework on the promotion may, therefore, be inevitable.

12.4.3 Improvement of Services for Foreign Visitors

A guidance and information provision system for foreign visitors has gradually been installed in Tokyo's transport systems over recent decades. The Japan Tourism Agency designated priority routes for guidance and information provision in the public transport network in 2012, and requested the commitment of various transport operators in the Tokyo Metropolitan Region to implement effective systems in this regard. Elsewhere, the road network's signage system has also been gradually improved in terms of English expression. These efforts may be intensively continued in conjunction with the expected increase in foreign visitors and the upcoming Tokyo Olympic and Paralympic Games 2020.

On the contrary, there is a significant issue regarding public transport fare systems. In the Seoul Metropolitan Region, a common fare system for the subway, commuter rail, and buses was introduced in 2004, even though the network is served by various private transport operators. In many European cities, a common fare system for the subway, trams, and buses has also been operational for many years. However, in the Tokyo Metropolitan Region, each transport operator uses its own fare system and fare levels are higher than the aforementioned cities. Such expensive public transport fares in Tokyo may reduce its attraction as a tourism destination and negatively impact visitor satisfaction. The effect of a discounted common fare system for foreign visitors and its financial and technological feasibility should be examined urgently.

12.4.4 Development of an Advanced Transport System Management Scheme

The Fukutoshin Line of the Tokyo Metro Company and the Toyoko Line of the Tokyu Corporation were connected at Shibuya Station in 2013, thereby creating the connection of five railway operators and six routes. This is the typical means of railway service improvement that characterizes Tokyo's railway network development, as noted in Sect. 12.3.1 (through train service). While this connection dramatically increased transport convenience in the region, complicated railway operation has resulted in severe train delays in the network. Even a minor delay occurring in the network may cause another (major) delay, and such problems can spread widely throughout the network. Kariyazaki (2011) analyzed the mechanism of delay propagation in urban railway systems and proposed several countermeasures for prevention and recovery. It is necessary to expand this study and to develop an advanced railway operation system for minimizing delays in a complicated train network.

Route choice patters in the Tokyo Metropolitan Region's expressway network will become diversified if its development is completed within the next few years. Hiraiwa (2012) showed that the number of routes from the Tomei Expressway to the Tokyo Central will increase from five to 1470 after completion of the radial and ring structured network. There was severe traffic accident involving a petrol tanker on the MEX in 2008. The disastrous resulting fire damaged the road infrastructure and resulted in heavy traffic congestion during 2 months of closure for restoration. Such risks will be minimized by the network's completion.

Development of the network aims to mitigate the traffic load on expressway links in central Tokyo by guiding through-traffic to ring road sections. Formerly, the toll per kilometer of the third ring Ken-o Expressway was more expensive than that of the other expressway sections subject to the reimbursement toll setting system. The Ken-o Expressway toll for through-traffic became much more expensive due to the higher fare rate and longer distance traveled, resulting in less motivation to use the third ring. To avoid this problem, a new toll system was implemented in 2016, wherein a distance-based toll system is applied and the toll from one on-ramp to another off-ramp is determined by the cheapest toll among all the possible routes. In the next development stage, a demand-responsive toll system should be considered and, ultimately, implemented to minimize traffic congestion.

12.4.5 Increasing Resilience to Disasters

As noted above, the transport system in the Tokyo Metropolitan Region should be more resilient to any kind of disaster, such as an earthquake, expected in the near future. The effects of the 2011 Great East Japan earthquake on the transport system have been gradually reported. Takayanagi et al. (2013) analyzed travels to home after the disaster using Twitter data. Fukuda et al. (2013) analyzed the effect of rolling blackouts on urban railway operation. Finally, Wada et al. (2013) analyzed the change in truck traffic volume in the northern part of the expressway network of the Tokyo Metropolitan Region. These studies tentatively discovered the effects on the region's transport systems; therefore, successive studies into such issues as the predominant factors to events above and assessments of potential countermeasures are needed.

Various transport operators and their supervisory agencies have drawn up business continuity plans (BCPs) in order to provide transport services after disasters. The author participated in a BCP committee for port services in Tokyo Bay before the Great East Japan earthquake. The first draft plan assumed that when serious damage by destructive shaking affected one port, the other ports suffering less destruction can accommodate the damaged port's business, considering the features of the expected type of earthquake in the region. However, the committee realized the risk of all six ports being damaged by a tsunami after the Great East Japan earthquake, leading to the inclusion of this additional damage scenario in the final plan. This example demonstrates that BCPs for transport services should take into account all possible types of risk and damage patterns, and should be revised frequently.

Increasing the resilience of Tokyo's transport system requires not only soft policies, such as BCPs, but also hard policies, including, e.g., the renewal of deteriorated infrastructures, as advocated above. For example, in 2013, the advisory committee on the MEX infrastructure renewal plan selected a 16-km section for infrastructure re-construction, a 4-km section for survey on re-construction, and 28 km for major repair works with regard to lifecycle cost, the possibility of service level improvement, and anticipated damage (Research Committee on Re-building of Structures on the Tokyo Metropolitan Expressway 2013). In response to this, the Metropolitan Expressway Company released its renewal plan, in which five sections totaling 8 km will undergo re-construction, and 55 km will undergo major repair works, at a total cost of 630 billion yen. It is expected that the total length of expressway sections requiring renewal will dramatically increase in the next two decades; therefore, the management scheme, including funding methods, should be urgently discussed. Furthermore, an advanced traffic management system to minimize the congestion caused by long-term closures and lane restrictions during re-construction and repair works should be studied.

12.5 Conclusions

This chapter analyzed major characteristics of the current travel demand in the Tokyo Metropolitan Region, reviewed the history of transport infrastructure developments and services in the region, and then discussed future perspectives on transport planning and management in the region, considering expected socioeconomic circumstances and technical innovations.

The most important and unique points of Tokyo's transport system are: (1) the development of the urban railway network by various private companies, associated with the through-train service connecting suburban commuter railways through subway links; and (2) the development of an urban expressway network that is seldom found elsewhere in the world. However, these advantages have caused other serious challenges, some of which remain to be overcome. Transport infrastructure development, which was the main focus in the region's transport plans for a long time, has already been completed, and it is obvious that our interest will shift to utilization and renovation of current infrastructure system.

The Tokyo Metropolitan Region has the largest metropolitan population globally, and its travel demand volume may also be the largest. Needless to say, urban railway network development before the motorization could make the world largest metropolis and make the metropolis more attractive in international city competition. While many mega-cities have recently appeared in Asia, the likes of Beijing and Jakarta are now suffering from severe traffic congestion caused by rapid motorization without an urban railway network. The author believes that the

Tokyo Metropolitan Region can compile knowledge on the TOD based on its experience and history, and is well-placed to propose an appropriate mega-city TOD concept to those cities.

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Chapter 13
The Changing Spatial Economy and Cultural Industries in Tokyo

Hiroshi Matsubara

Abstract The Tokyo metropolitan area is the largest world city-region globally, and is the location where many of Japan's advanced functions are centralized. The competitive power of new cultural industries has been demonstrated in recent years. To enhance creativity and strengthen the international competitiveness of cultural industries, it is important to convert the internal structure of Tokyo's urban areas and to accelerate connections among various industrial agglomerations in the metropolitan area.

Keywords World city · Cultural industries · Movie industry · Agglomeration · Tokyo metropolitan area

13.1 Introduction

About 30 years have passed since the late 1980s, when a new approach on world cities (or global cities) appeared in urban studies (Friedmann 1986; Sassen 1991). Many empirical studies have revealed the characteristics of typical world cities and the dynamics of world city networks. The hierarchy of world cities has been strongly influenced by the organizational structures of multinational companies and those spatial development across the globe. The globalization of finance has played another important role in the growth of world cities. In accordance with increasing outward investments and the liberalization of financial markets in the 1980s, three international financial centers, London, New York, and Tokyo, grew rapidly and synchronously (Matsubara 1995).

However, the weakness of the Tokyo market became an issue in the early 1990s when Japan's asset price bubble collapsed. Although good performance has continued in London and New York, the position of Tokyo as Asia's leading international financial market is threatened by Singapore (Matsubara 2014).

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Regarding the new developments of this approach, international comparison of the geography of cultural industries has become one of the most important subjects (Power and Scott 2004). Considering recent topics, such as emerging urban competition in Asia and clustering of various cultural industries, this chapter aims to clarify the changing spatial economy and cultural industries in Tokyo.

The following section will consider Japan's urban system through empirical analysis. In the third section, changes in the internal structure of urban areas will be discussed; the forth section will then examine recent changes in and characteristics of the agglomeration of cultural industries in Tokyo.

13.2 Changing Urban Systems of Japan

The Tokyo metropolitan area is the world's largest urban agglomeration and has strengthened the centrality of many of the advanced functions in Japan. The status of each of Japan's metropolitan areas has changed, as shown by their respective population share, manufactured goods shipments, wholesale sales, employees of information service industries, corporate head offices, and foreign companies (Fig. 13.1). Osaka's shares have decreased in some categories, such as manufacturing and wholesale, whereas recent important functions of international finance and information services have been concentrated in Tokyo.

Regarding the relatively recent changes following the collapse of Japan's bubble economy, three points are remarkable (Matsubara 2007). First, the tendency of the population to concentrate in Tokyo is continuing. Second, concerning the level of industrial shipments, Nagoya's share is increasing, reflecting the growth of the automobile industry. Third, after declines in the 1990s in the wholesale and information service functions, Tokyo's shares of such functions have been increasing again since 2000 under an advanced information economy.

13.3 Transformation of Internal Structure in the Tokyo Metropolitan Area

In tandem with the announcements that Tokyo was growing as a world city, the internal structure of Tokyo drastically changed in the late 1980s and early 1990s. Some older residential areas adjoining the central business district (CBD) were

Fig. 13.1 (continued) corporate head offices (companies capitalized at 1 billion yen or more). (**f**) Number of foreign companies (companies capitalized at 1 billion yen or more)

Notes: Tokyo metropolitan area: Tokyo, Kanagawa, Saitama, and Chiba Prefectures. Osaka metropolitan area: Osaka, Hyogo, Kyoto, and Nara Prefectures.

Nagoya metropolitan area: Aich, Gifu, and Mie Prefectures

Sources: Population Census, Industrial Statistics Survey, Census of Commerce, Financial Statements Statistics of Corporations by Industry

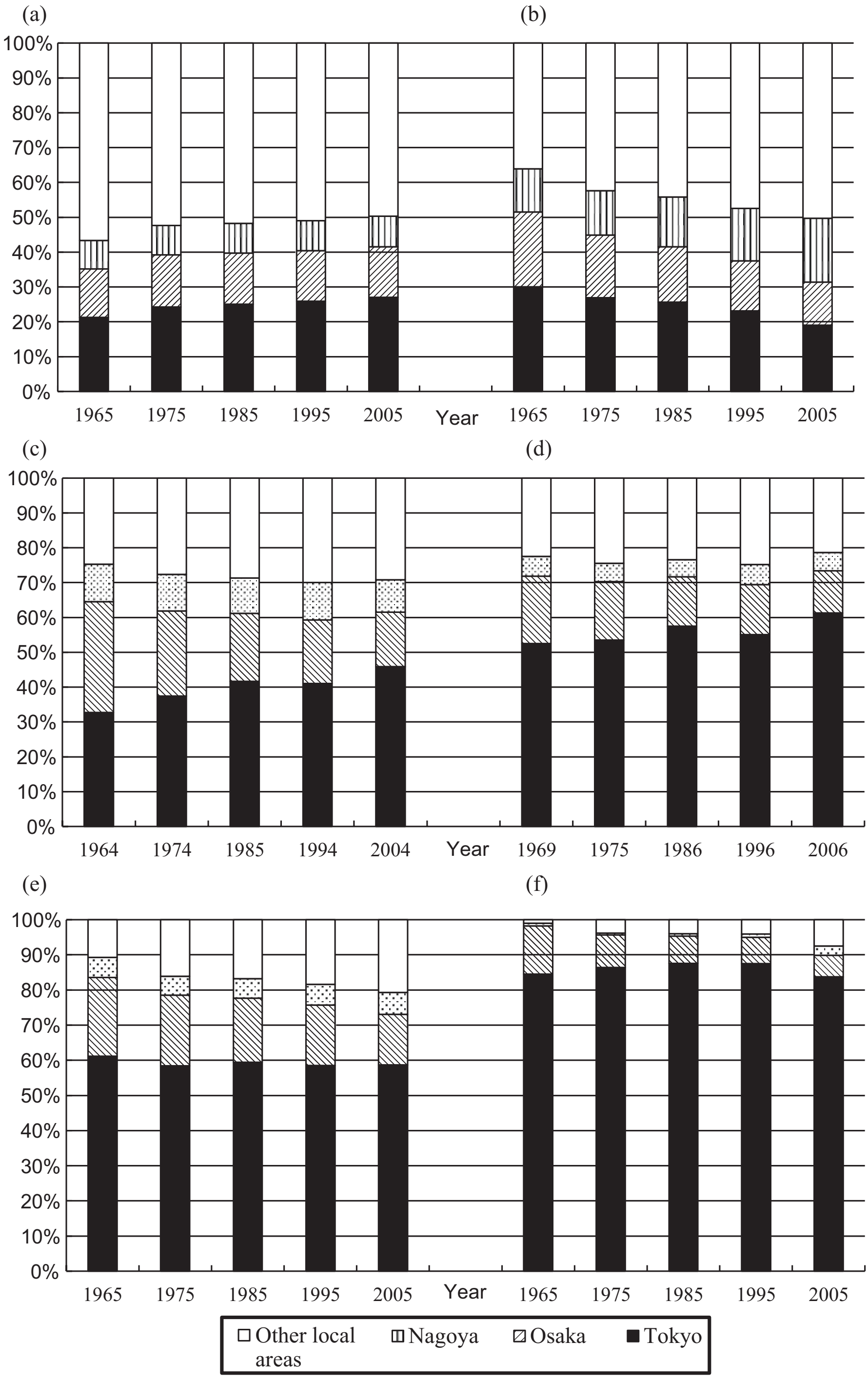

Fig. 13.1 Changes in shares of Tokyo, Osaka, and Nagoya metropolitan areas in relation to Japan as a whole (Matsubara 2014) (**a**) Number of Population. (**b**) Manufactured goods shipments. (**c**) Wholesale sales. (**d**) Number of employees of information service industries. (**e**) Number of

destroyed to construct office buildings. The old factories and warehouses in the waterfront areas were also replaced by newly built offices and condominiums (Hoyano et al. 2002). In addition, suburban business centers, such as Makuhari in Chiba and Minato Mirai 21 in Yokohama, were developed to assist in the decentralization of administrative functions from Tokyo's core areas.

However, since the collapse of Japan's asset inflation-led economy, land prices have shown a tendency to decrease (Fig. 13.2a). Until 2006, many years after the collapse, both residential and commercial land prices continued to decline. The office market exhibited a large excess of supply over demand, and much unoccupied land and many vacant offices remained.

This depression in the price of land caused a large number of high-rise condominiums to be constructed inside the metropolitan area (Fig. 13.2b). This active provision of accommodation has engendered the recent population growth in the central area of Tokyo. The population in the three central wards (Chiyoda, Chuo and Minato wards), grew from 244,000 in 1995 to 268,000 in 2000, then increasing further to 375,000 in 2010.

Since 2000, the supply of office floor space has again increased in Tokyo's central wards area, following active redevelopment projects, such as Shiodome, Roppongi, and Marunouchi. Fig. 13.2b shows the supply trends of office floor space

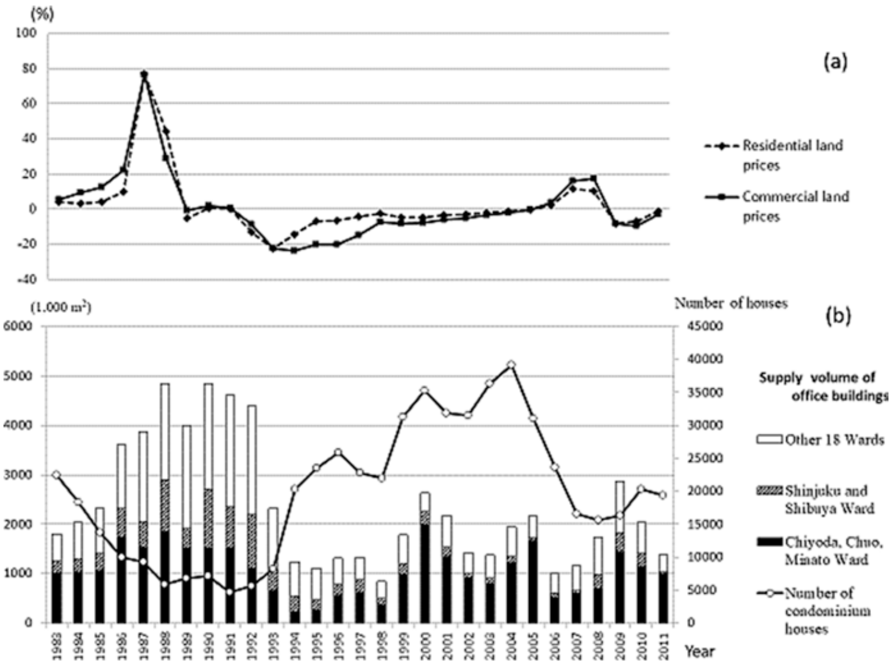

Fig. 13.2 Changes in land price ratio (**a**) and supply trends of condominium houses and office space (**b**) in Tokyo (Source: Tokyo no Tochi)

in the three central wards and the other 20 outer wards. Although the supply in the central wards was exceeded by that in the other 20 from 1988 to 1999, this was reversed in 2000, and this trend continues today.

To revitalize Japan's economy, the national government has designated an emergent development area in the center of Tokyo, based on the "Law on Emergency Measures for Urban Regeneration" enacted in 2002. Inside the emergency development area, the normal time needed to redevelop has been shortened, and the permitted floor space ratio has been increased. Such policies suits developers' interests because productive use of space is important for developers to increase their profits.

Demand for office space to expand business operations in the center of Tokyo has also been increasing, reflecting the recovery trend of the Japanese economy since 2002. The rate of vacant rented offices in the 23 wards of Tokyo declined from 9.6% in 1994 to 2.6% in 2006, and the annual growth rate of rents in the large-scale office buildings has reached 10% in recent years. In addition, as one of the factors behind the recent expansion of real estate investment markets, the emergence, in the past few years, of "real estate securitization" schemes has been observed.

The restructuring of manufacturing industries, under the pressures of globalization, has had powerful impacts on the industrial structure in the 23 wards of Tokyo. Most regions are suffering from a decline in their manufacturing industries and wholesale and retail trade, accompanied by the depression of finance and insurance. Conversely, the number of employees of service industries, such as internet-based services and the creative industries, has risen since the early 2000 (Fig. 13.3).

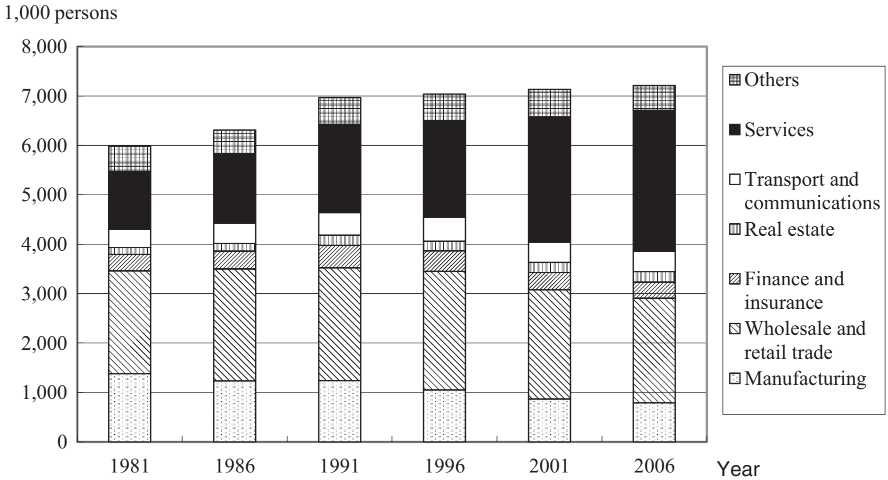

Fig. 13.3 Employment change by industry in the 23 wards of Tokyo (Matsubara 2014) (Source: Establishment and Enterprise Census 2006)

13.4 Geographical Agglomeration of Cultural Industries in Tokyo

Regarding to the definition of cultural industry, several different conceptions may be found, and it is difficult to determine precisely from the actual statistics. In this chapter, the following will be considered within the definition of a cultural industry: publishers, printing and allied industries, newspaper publishers, broadcasting, video picture information production and distribution, sound information production, and internet-based services, based on the industrial classification used in the 2006 Establishment and Enterprise Census.

Figure 13.4 presents a breakdown of the number of establishments by number of employees. Tokyo has many small establishments, over 50% of which have three or fewer employees. The ratio of small establishments in printing and allied industries is higher than that of publishers. Compared with broadcasting, video picture information production and distribution indicates a higher rate of small establishments.

Regarding changes in the number of employees, we find a clear contrast between older and newer cultural industries. Between 2001 and 2006, a decline in printing and allied industries in the outer 16 wards and growth in publishing and video picture information production in the urban center are both notable. In particular, growth in the urban center and sub-center in internet-based industries is conspicuous.

Printing and allied industries show a high exit rate. It has been noted that business successions are not progressing smoothly among SMEs due to various factors.

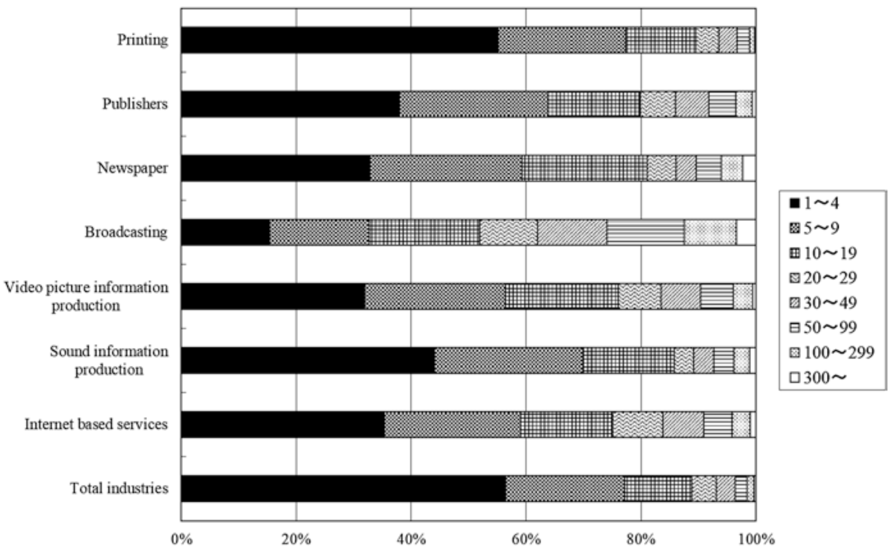

Fig. 13.4 Number of establishments by number of employees. (Source: Establishment and Enterprise Census 2001, 2006)

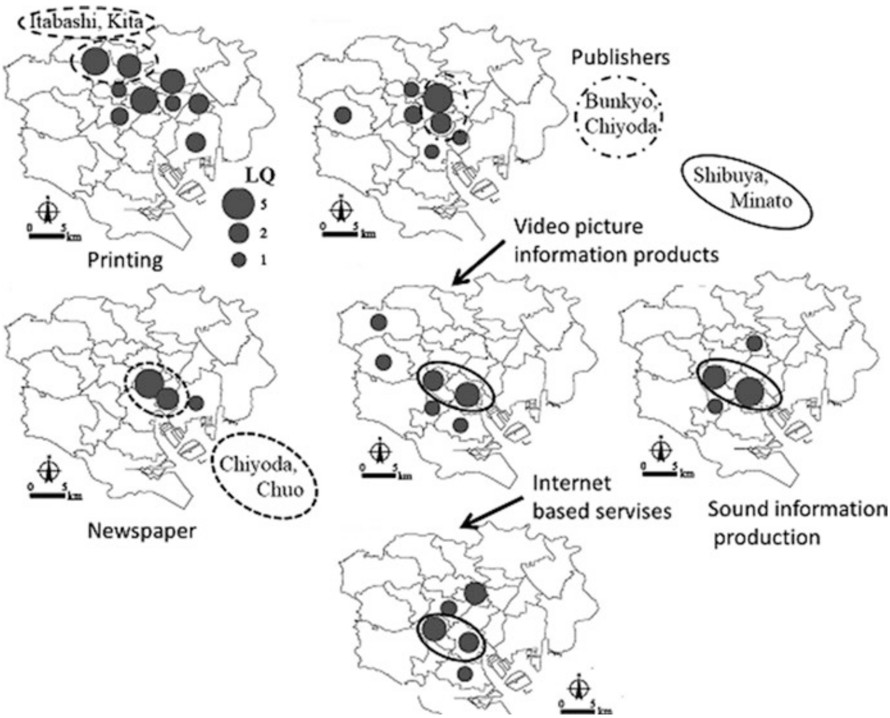

Fig. 13.5 Location Quotients in the 23 wards of Tokyo (Modified from Matsubara 2014. Source: Establishment and Enterprise Census 2006)

The influence of urbanization and the increase in land prices can be regarded as among the major factors in this regard.

Figure 13.5 shows the geographical distribution of areas with a high location quotient by each cultural industry in the 23 wards of Tokyo. Although newspaper and other publishers are concentrated in the core area, such as Chiyoda ward, Chuo ward, and Bunkyo ward, printing and allied industries are dispersed in the surrounding areas of central Tokyo, such as Sumida ward and Arakawa ward to the east, and in the northern outer areas, such as Kita ward and Itabashi ward. We, thus, find a spatial division of labor between publishers and printing in the Tokyo metropolitan area.

Conversely, new cultural industries, such as video picture information production and distribution, sound information production, and internet-based services, are concentrated in Minato ward and Shibuya ward on the western side of Tokyo's core. Broadcasting also indicates higher location quotients in Minato ward and Shibuya ward. A strong relationship between the location of broadcasting and the agglomeration of new cultural industries has been observed.

Regarding the recent situation of the new cultural industries, Hanzawa (2004) contrasted two Japanese cultural industries – animation and home video games – by examining their key characteristics: location patterns, labor markets, and inter-firm relationships. Both industries are concentrated in small firms within Greater Tokyo, and both exhibit close inter-firm relationships. Within Tokyo, almost all animation firms are located in the western suburbs of Tokyo, and the agglomeration of video game firms is in the central area. As Hanzawa explained, this locational difference arises from divergences in the development paths of these animation and game firms. He also analyzed the location of the production firms of TV programs. These firms need to be close to key commercial television stations, such as Tokyo Broadcasting System Television in Akasaka and TV Asahi Corporation in Roppongi.

This chapter focuses particularly on the movie industry. The Japanese movie industry, which, like Hollywood, has a long history dating back to the1920s, has been recognized as a declining industry since the 1960s, due to the power enlargement of TV and rental video shops. However, since 2000, the distributors' income and the number of Japanese films released have again increased. In 2006, the market share of Japanese films surpassed that of imported films.

In recent years, the ratio of Japanese films been produced by the production committees, "*Seisaku Iinkai*" in Japanese. These committees are formed of different kinds of agents, such as movie companies, TV companies, advertising agencies, publishers, and newspaper publishers. In particular, TV companies have played an important role as very influential agents in the growth of markets.

In these circumstances, Japanese major movie companies, such as Shochiku, Toho, and Toei, have again increased the ratio of movie and TV divisions, compared with real estate and other divisions (Fig. 13.6). Each company has one or two stu-

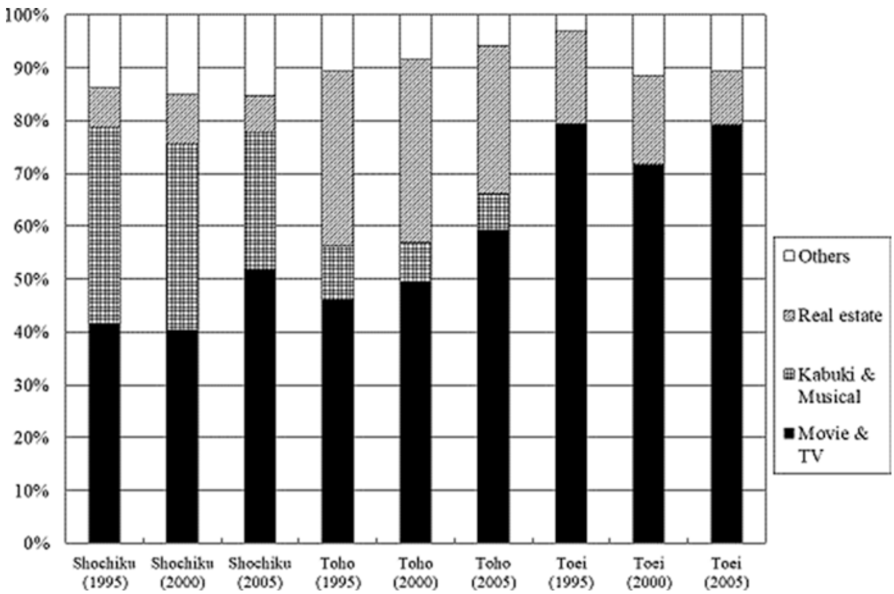

Fig. 13.6 Japanese major movie companies and changes in the composition ratio of sales by division (Source: Each company's Annual Report for 1995, 2000, and 2005)

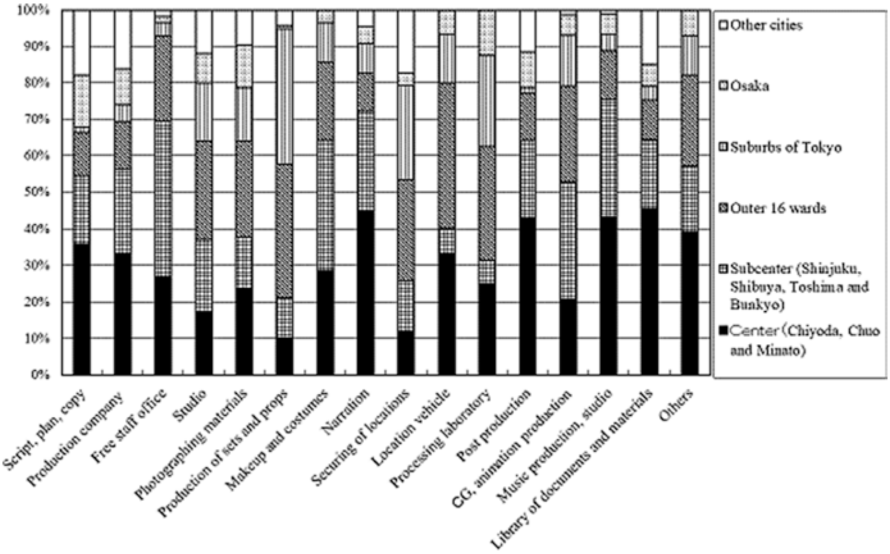

Fig. 13.7 Locational characteristics of video picture information production companies (Source: Uni Eizo Nenkan 2003; Uni Press Service, Co. 2003)

dios in Tokyo and/or Kyoto, and some directly operated theaters in major cities, such as Tokyo, Osaka, and Fukuoka. To produce films and TV programs and operate those facilities, it has organized many subsidiaries and affiliated companies. In addition, Toho has rental space available for use by other companies in Kinuta (Setagaya ward) Studio, which was established in 1943, and Toei uses Kyoto Studio as a theme park called Toei Uzumasa Eigamura.

The movie industry's production process is generally divided into four parts: development, preproduction, production, and post-production. Each process is supported by many agents, in particular by very small and specialized companies. Figure 13.7 shows the locational characteristics of video picture information production companies, based on the special directory. We find functional and spatial divisions of labor, and the locational patterns are classified into three types:

1. companies mainly located in central Tokyo (narration, post-production, music studios, etc.);
2. companies mainly located in Tokyo's sub-center (free staff office, costume/hair and makeup, computer graphics (CG) and animation, etc.); and
3. companies mainly located in Tokyo's suburbs (stage properties and setting, vehicles and laboratory, etc.)

Agglomeration is theoretically explained as an outcome of the minimization of transaction costs through vertical disintegration of production (Scott 1988). Scott (2005) also analyzed the dynamics of locational agglomeration of the motion-picture industry in Hollywood. To explain the location of the Japanese movie industry, it is necessary to consider the viewpoints of both agglomeration and spatial divisions of labor.

13.5 Concluding Remarks

It is very difficult to integrate the topics in the two preceding sections: transformation of the internal structure of the Tokyo metropolitan area and the geographical agglomeration of cultural industries in Tokyo. In this conclusion, I seek to examine perspectives on the Japanese cultural industries and the spatial structure of Tokyo.

The Ministry of Economy, Trade and Industry (METI) organized a "Contents Global Strategy Study Group," which published its final report in 2007. In this report, "Globalization", "Innovation," and "Changes in financing," intertwined with one other, are claimed to be forming an "upward spiral of scale." This upward spiral is accelerating the globalization of contents businesses and making the global contents market more competitive. The development of digital contents is also accelerating integration of the different types of contents, such as films, TV programs, music, and comics. In these circumstances, the report observes that as various genres of contents are integrated, Japanese contents may generate larger synergistic effects than those of other countries.

However, this perspective seems optimistic. One of the key problems is an institutional and/or organizational barrier specific to each cultural industry. The overall cultural industry retains a strong culture of subcontractor use, in which subcontractors make product contents for the Japanese market within the existing framework.

Another problem is the lack of a geographical perspective. As noted above, Japanese cultural industries differ markedly in their detailed location patterns. To successfully integrate the different types of cultural industries, it is necessary to consider the geographical background and the location factor in each cultural industry.

Although it is recognized that the contents industries have two aspects, namely culture and business, METI focused solely on the business aspect in this report. However, it is more important to focus on the aspect of culture. For the competitiveness of some cultural industries, creativity is indispensable, and is often influenced by cultural peculiarity and a specific geographical environment.

The Tokyo metropolitan area is the largest world city-region and has strengthened the centrality of many advanced functions in Japan. The competitive power of new cultural industries, such as animation and video game software, has also been demonstrated in recent years. However, considering the viewpoint of global competition among world cities, Tokyo is suffering numerous problems, including expensive land and commodity prices, several kinds of congestion phenomena, and inconvenient infrastructures. As Tokyo is too large and disorderly, it is difficult to access important information on new business opportunities and to develop close inter-firm relationships. To enhance creativity and strengthen the international competitiveness of cultural industries, it is important to convert the internal structure of Tokyo's urban areas, to accelerate multi-polarization, and to construct comfortable space in the metropolitan area.

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Chapter 14
Regional Characteristics of Urban Tourism in Tokyo

Eranga Ranaweerage, Takayuki Arima, and Toshio Kikuchi

Abstract Tokyo continues to grow as a global urban tourism destination. Urban tourism spots in Tokyo differ from one another in terms of their attractiveness. In this chapter, we discuss the historical dimensions of how such attractiveness has formed and changed over time, based on three case studies of famous tourism spots in Tokyo: Asakusa, Ginza, and Odaiba. Asakusa provides insights into urban tourism dating back to the Edo period and its changes up to present. Ginza represents a modern case of urban tourism, dating back to Meiji period, and Odaiba represents urban tourism in Tokyo in the twentieth century. In each case, we clarify the changes in the five common elements of attractiveness in urban tourism: "seeing," "buying," "dining," "gathering," and "relaxing."

Keywords Tokyo · Urban tourism · Attractiveness of urban tourism · Regional characteristics · Historical dimensions

14.1 Introduction

Globally, Tokyo is an exceptionally unique metropolis, with several districts of individual identity that have become urban tourism spots (Fig. 14.1). According to Jinnai (1992), Tokyo is very complex, difficult to understand, and different from Western cities, where aesthetic cityscapes are a common character. The complex characteristics and large variety of tourism attractions make Tokyo a unique space

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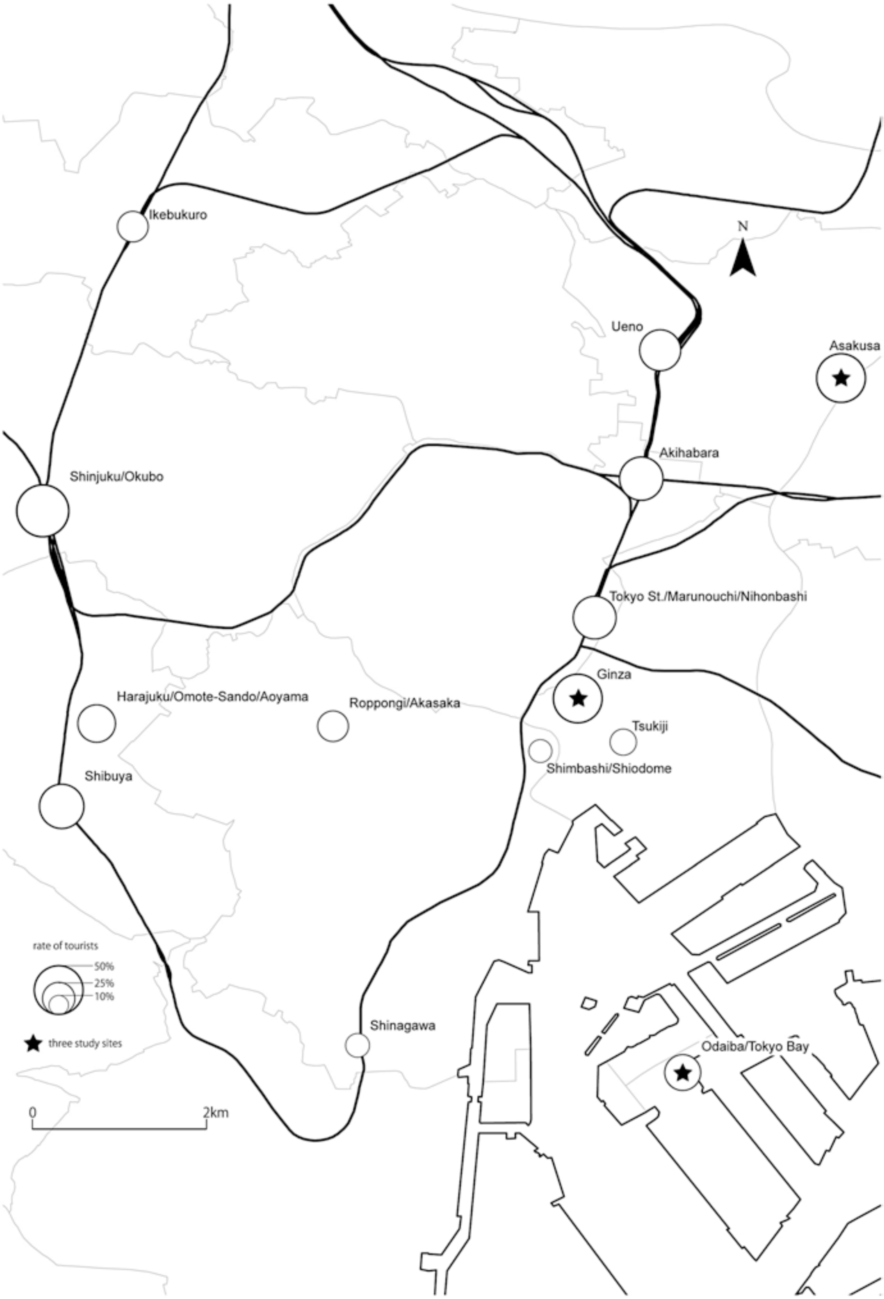

Fig. 14.1 Main urban tourism areas in Tokyo (Based on tourism status survey, Tokyo Government 2015)

among other urban tourism destinations globally, allowing travelers to experience a different atmosphere from their ordinary life.

Tokyo attracted 8 million overseas tourists in 2014 (a 30% increase from the previous year), along with 506 million domestic tourists. Being the host for the Olympics and Paralympics in 2020, the number of overseas tourists to Tokyo is expected to grow to 15 million in 2020 and 18 million in 2024 (Tokyo Metropolitan Government 2015). The Tokyo Metropolitan Government's long-term vision aims to make Tokyo the world's best urban tourism destination, and plans various improvements in Tokyo's inbound environment for tourists. The main targeted areas for improvement are overcoming language barriers, effective utilization of information and communication technology, implementation of international service standards, ability to cater for the diverse cultures and customs of tourists, ensuring the safety of tourists in case of emergencies, and adopting universal designs for physically challenged tourists. Thus, as Tokyo continues to grow as a global urban tourism destination, it is important to understand the historical perspectives and process of change in Tokyo's attractions, together with the future challenges, in the context of urban tourism.

14.2 Spatial Scale of Urban Tourism in Tokyo

The spatial scale of urban tourism in Tokyo is generally described based on Tokyo as a whole or with reference to certain tourism attractions, such as Tokyo Tower. In this chapter, we define the spatial scale as the range of walking by tourists. In urban tourism, tourists reach their destinations on train or by vehicle, but they mostly engage in sightseeing on foot in a fixed space. Consciously or unconsciously, people who live or work in areas where urban tourism occurs are those who have created urban tourism spots. Simultaneously, tourism spots are constantly influenced and changed by tourist behavior (Fig. 14.2). In other words, urban tourism spots are

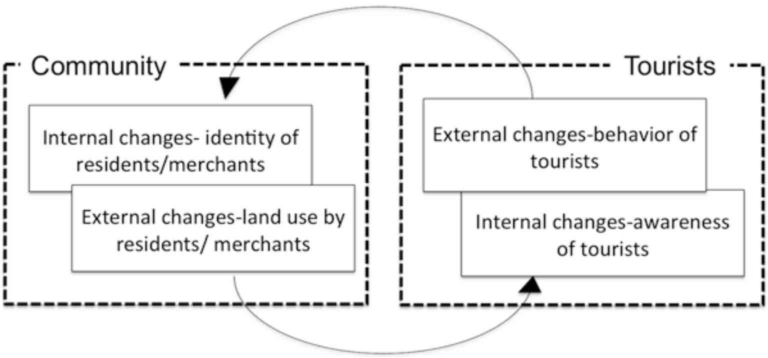

Fig. 14.2 Interrelationship between community and tourists

composed of the interrelations between the community (residents and merchants) and tourists. In particular, direct interaction between tourists and residents or merchants occurs easily in the range of walking by tourists during tourism activities. Therefore, we consider that observations on the range of walking is extremely important in urban tourism research and studies, as well as in tourism planning, as it facilitates understanding of the relationship between the community and tourists.

14.3 Attractiveness of Urban Tourism in Tokyo

The attractiveness of urban tourism may differ between individual tourists However, the editorial committee of "Machizukuri through urban tourism" (2003) identified five common elements of attractiveness of Japan's urban tourism: "seeing," "buying," "dining," "gathering," and "relaxing" (Fig. 14.3). In this chapter, we examine these five elements with examples of urban tourism in Tokyo.

14.3.1 Attraction of "Seeing"

The attraction of "seeing" mainly refers to the landscape of urban tourism spots. For example, cobblestones in central Tokyo, the little Kyoto in Tokyo (namely Kagurazaka), and the city landscape of high-rise-buildings in Shinjuku can be identified as some of the attractive landscapes (Figs. 14.4 and 14.5). Visual sensation is regarded as the most impressive and memorable of the five senses. Therefore,

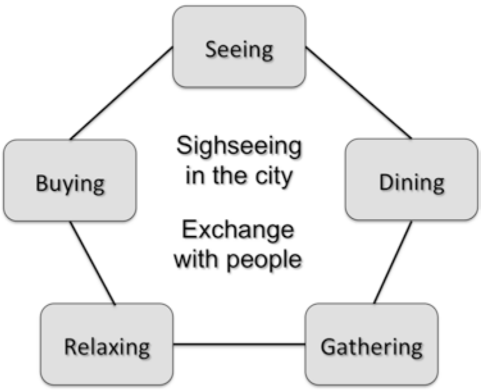

Fig. 14.3 Five elements of attractiveness in urban tourism (Based on the editorial committee of Machizukuri through Urban Tourism 2003)

Fig. 14.4 A stone pavement in Kagurazaka (photographed by Kikuchi in 2010). Stone pavements remain in Kagurazaka, alongside the Japanese-style restaurants. Tourists can enjoy walking in the small streets in the area

preservation, generation, and presentation of the landscape convey an important meaning to urban tourism.

14.3.2 Attraction of "Buying"

A city is a place where many commercial functions, including shopping complexes, are concentrated. In Tokyo, some examples of where tourists can enjoy buying include the fashion shops in Harajuku targeting young people, and the wholesale kitchen tools and restaurant supply shops that line Kappabashi Street (Fig. 14.6). Apart from buying, simply seeing these commercial facilities and functions in urban areas, which is commonly known as window-shopping, has also become a major attraction of urban tourism.

14.3.3 Attraction of "Dining"

A city is also a place for diverse cuisines from different localities, both inside and outside a country. There are interesting cases of unique food cultures in Tokyo, created through large concentrations of people in one space, such as Korean food

Fig. 14.5 High-rise-buildings in Shinjuku (photographed by Kikuchi in 2006). Several of Tokyo's tallest buildings are concentrated in Shinjuku, including the Tokyo Metropolitan Government Office, where tourists can enjoy a view of Tokyo from the observatory deck for free

restaurants in Shin Ohkubo (Fig. 14.7). Further, when a certain food trend emerges, there are cases in which restaurants offering the same dishes become concentrated in one place. One typical example is Monja Street in Tsukishima, where there is a large concentration of Monjayaki restaurants (Fig. 14.8).

14.3.4 Attraction of "Gathering"

The attraction of "gathering" refers to the experience generated through the gathering of many people from across the world in one place. Large urban areas are suitable for large gatherings, such as famous international exhibitions due to the easy accessibility produced by transport developments. "Gathering" not only concerns attractiveness derived from the gathering of outsiders. In some cases, tourists visit a place to see the gatherings of local residents, such as at festivals (Fig. 14.9). Urban festivals can be seen as an attraction generated through the gathering of local people and tourists.

Fig. 14.6 A store for dishes, pots, and kitchen items on Kappabashi Street (photographed by Kikuchi in 2010). Kappabashi is a shopping street with specialized shops for cooking utensils and other restaurant supplies

14.3.5 Attraction of "Relaxing"

The attraction of "relaxing" mostly concerns the natural environmental elements of urban tourism. For example, urban parks, such as Ueno Park and Shinjuku Gyoen, are precious green spaces in Tokyo (Fig. 14.10) that have become relaxing spaces for people within other crowded and man-made urban tourism spots.

Urban tourism spots in Tokyo differ from one another in terms of their attractiveness. We discuss the historical process of how such attractiveness has formed and changed over time, based on three case studies of famous tourism spots in Tokyo: Asakusa, Ginza, and Odaiba. Asakusa provides a good example of urban tourism dating back to the Edo period. Ginza represents a more modern case of urban tourism since the Meiji period, while Odaiba is an example of urban tourism in the twentieth century. Therefore, the three cases identify three types of urban tourism in Tokyo: traditional, modern, and new urban tourism.

Fig. 14.7 Korean Town in Shin Ohkubo (photographed by Ranaweerage in June 2016). Streets in Shin Ohkubo are lined with Korean food restaurants, including Korean barbecues

Fig. 14.8 A Monjayaki Restaurant in Tsukushima (photographed by Kikuchi in 2015). Monjayaki or Monja is a Japanese style pancake with cabbage and other fillings. About seventy Monjayaki restaurants are located in Tsukushima, and each restaurant has developed its own flavor

Fig. 14.9 Sanja Matsuri (Photographed by Toshio Kikuchi in May 2015). This is an annual festival in Asakusa where tourists can stampede with the carriers of portable shrines

Fig. 14.10 Ueno Park in spring (photographed by Kikuchi in 2016). Ueno Park, located in central Tokyo, is a popular cultural and relaxing space for tourists, and has various attractions, such as museums, art galleries, Shinobazu pond, and Ueno Zoo, which is also popular with tourists

Fig. 14.11 Main gate of Sensouji Temple (photographed by Yuka Hasegawa in 2013). This is the entrance to Sensouji Temple and a representative place for urban tourism in Asakusa

14.4 Urban Tourism in Asakusa: Origins and Changes

The general place image for Asakusa may be the scenery from the Kaminarimon (main gate) of Sensouji Temple, along Nakamise Street towards the main hall (Fig. 14.11). While this Buddhist temple is the central tourism attraction in Asakusa, the area also features many other tourism attractions, including the theatre district of Asakusa Rokku and sightseeing waterbus services along the Sumida River. Here, we discuss the historical perspectives that led to the formation of tourism attractions in Asakusa and the changes of attractions over time.

Asakusa tourism dates back to the origin of Sensouji Temple. It was built to worship the sacred statue of Kanon found in Sumida River in 628 AD by two fishermen. Many worshipers have visited the temple since then. The day of the annual Sanja Festival at Sensouji Temple attracts many tourists and large numbers of people to Asakusa. Therefore, "gathering" is the oldest form of the urban tourism attractions found in Asakusa's history.

In the late 1980s, a theatre district called Asakusa Rokku was created on the western side of Sensouji Temple. Asakusa Rokku, featuring show tents, theatres, and cinema halls, enjoyed great success in attracting visitors until around 1960. Asakusa Rokku was an area where tourists spent a lot of money on entertainment

Fig. 14.12 Open facilities for tourism at Sumida Riverbank (photographed by Yuka Hasegawa in April 2016) In spring, the area becomes a popular cherry blossom spot in Tokyo. Tourists can also enjoy the cityscape on a waterbus

and purchasing goods, implying that Asakusa Rokku was mainly focused on "buying" functions during this period.

However, the theatres and cinemas of Asakusa Rokku failed to remain compatible with ongoing social changes. Consequently, large business facilities, such as shopping complexes, were built in the area in the 1980s, thereby changing the characteristics of "buying" in Asakusa Rokku. During the stagnation of Asakusa Rokku, some new tourism spaces were developed on the eastern side of Sensouji Temple, concentrated on Sumida River. For example, a pedestrian bridge was built over Sumida River and a public park along the riverbank. These open facilities along the Sumida Riverbank, which began in 1985, made Asakusa a place for "relaxing," adding a new characteristic to its tourism (Fig. 14.12). Historical aspects of tourism in Asakusa show that the changes of tourism attractions were closely related to changes in society. It also seems that the changes in tourism attractions may have led to the area's increasing reputation as an urban tourism spot.

Even today, Asakusa attracts many tourists. However, the status of each attraction differs. Asakusa Rokku is not as crowded with tourists as in its heyday, and is experiencing a steady decline, while Sumida Riverbank has become popular as a new tourism spot. Asakusa's urban tourism has shown clear spatial changes by moving its central focus from the western side (Asakusa Rokku) to the eastern side

(Sumida River) of Sensouji temple. Therefore, the spatial scale of urban tourism in Asakusa is clearly indicated by the range of Asakusa Rokku, Sensouji Temple, and the terrace facilities at Sumida River.

In recent years, Asakusa has been welcoming an increasing number of overseas tourists, and this number is expected to further increase in the coming years. It is, therefore, important to consider how Asakusa's attractions will facilitate overseas tourists and what attractions these new travelers may prefer. The focus of attraction may change or expand again, accordingly.

14.5 Urban Tourism in Ginza: Origins and Changes

Nowadays, Ginza is known as an upscale shopping district with high-class brand shops and clubs (Fig. 14.13). Being a major commercial area, Ginza has become an attraction for urban tourism. As in the previous section on Asakusa, here we discuss how Ginza became an urban tourism attraction and what kind of changes have occurred in the area by examining the history of Ginza.

Fig. 14.13 Ginza 4-chome crossing (photographed by Yuka Hasegawa in 2015). Ginza is an urban tourism spot where a large number of tourists gather to buy branded goods and enjoy branded clubs

Ginza's name originates from its initial purpose as a silver coin foundry for the Edo shogunate. Subsequently, Ginza became a firebreak space after the devastating Great Fire of Meireki, which brought many people to the area. Ginza was also positioned on the Tokaido route, resulting in the formation of many shops in the area. Accordingly, the oldest form of urban tourism attraction in Ginza was the joy of "buying."

The opening of a railway between Shimbashi and Yokohama in 1872 enabled Ginza's business functions to flourish and expand, due to its close proximity to Shimbashi station. The new railway also enabled foreigners entering Japan through Yokohama Port to visit Ginza at that time. Consequently, Western style pubs and cafes started to appear in the area. However, a massive fire struck Ginza in the same year, causing huge damage to the lives of local people. After the devastating fire, Ginza's streets and buildings were rebuilt with bricks. The red-brick constructions created a unique landscape in Ginza, attracting many visitors. Ginza, thereby, became an enjoyable visual sensation, along with its increasing attractiveness for "buying."

A huge neon sign, which was introduced to Ginza in 1952, marked a turning point in significantly changing the landscape of Ginza. Today, Ginza is vibrant, with extensive multicolored signage on buildings and rooftops, which is a key feature of its current landscape. In other words, the business functions of Ginza have created the attractions of "seeing" that strengthen and complement its attractions of "buying."

In summary, Ginza's tourism attractiveness is mainly focused on the attractions of "buying." The visual impact of Ginza's charming architecture and landscape has strengthened its functions and attractiveness for shopping. Tourism in the area shows a tendency to continue focusing on "buying," even in the years ahead. The spatial range of urban tourism in Ginza has not changed over the years, and Ginza has been attracting regular visitors interested in upscale shopping. This sustainability could be seen as attributable to Ginza's sensitivity to social changes and proper identification of consumers' needs. However, in recent years, an increasing number of similar types of urban tourism spots have appeared in Tokyo, focusing on upscale shopping. It is, therefore, important for Ginza to sustain its tourism functions by differentiating itself from these emerging tourism spots, which cater for similar interests.

14.6 Urban Tourism in Odaiba: Origins and Changes

Odaiba is representative of urban tourism in Tokyo today, and attracts a large number of domestic and international tourists every year. It is a man-made island, constructed through a project overseen by the Tokyo Metropolitan Government. The name derives from seven cannon batteries that were installed in Tokyo Bay in 1853.

Marine parks, including Odaiba Seaside Park, existed in Odaiba even before full-scale developments started in the area. The main tourism resource in Odaiba was the

Table 14.1 Descriptions about Odaiba in guidebooks in 1994

Attraction	Area	Distinctive expressions	No. of pages
Rainbow bridge	Daiba	Promenade with sightseeing space at every turn	0.8
		Promenade in the left and rigt sides of the bride	
		Glance over Tokyo bay while walking in the seaside	
		Panoramic view spread out before you	
		Observation decks in both Shibaura side and Daiba side	
Odaiba Seaside Park	Daiba	Accessible only on promenade or waterbus	0.1
Museum of Marine Science	Aomi	Full view of the sunrise and Daiba area	0.1
		Observation room are 70 m above the ground	
		Rainbow bridge and downtown skyscrapers	
		State of ongoing construction work	
		Go around the observation rooms leisurely	
		You'll be surprised with the enriched contents	
No of pages introducing Odaiba (among total of 160 pages)			0.1

Based on Rurubu Johouban Kanto 6 Tokyo '95

Fig. 14.14 Head office of Fuji TV Network (photographed by Kikuchi in 2006). Fuji TV Network's head office is a landmark building in Odaiba

aqua-based urban landscape that enabled people to relax at the waterfront and enjoy the views from marine parks. Therefore, Odaiba's oldest form of tourism attraction can be identified as "relaxing."

Influenced by the planned World City Expo '96 in Odaiba, tourism facilities were constructed successively. However, when the new mayor canceled the World City Expo in 1995, these constructions were abandoned and Odaiba was frequently referenced in the media as a lost legacy. There was no indication of its potential as an urban tourism destination at that time (Table 14.1). However, several businesses were able to flexibly respond to this harsh situation. For example, DECKS Tokyo Beach, which is a large commercial facility in Odaiba, resembling a large vessel, was able to attract many tourists by changing its management policy from focus on the World City Expo to an aqua-themed tourism facility, reminiscent of earlier times in the area. Further, by 1998, three more tourism facilities appeared in the surrounding area of Odaiba Seaside Park. Among these facilities was the head office of Fuji Television Network, which largely contributed to the development of Odaiba by broadcasting a program about Odaiba's aqua-based urban landscape (Fig. 14.14). Further, guidebooks and other media covered information about broadcasting booths in the Fuji TV's head office and nearby shops (Table 14.2). Consequently, Odaiba started to become widely recognized and attract many visitors. During this period, the main urban tourism attraction was "seeing."

In 1999, Palette Town, a large commercial facility, was established in the Aomi area. Palette Town has two main facilities: MEGA WEB (Car showrooms) and Venus Fort (a shopping mall). Due to the geographical conditions, Venus Fort could not utilize Odaiba's aqua-based tourism resources as its theme. Therefore, it created a different concept based on European-style cityscapes and included an open-air area. Palette Town, thus, enabled visitors to enjoy a new experience, and became a popular tourist spot for shopping in Odaiba. Information provided in the media also began to concentrate on introducing shopping events and new products in each commercial facility (Table 14.3). Gradually, Odaiba's tourism transformed into a shopping-related consumptive space, focused on "buying," from its previous aqua-based attractions for "relaxing."

14.7 Potential Developments of Urban Tourism in Tokyo

Tourism development is largely influenced by the economic, political, and cultural changes in society. For example, the stagnation of Asakusa Rokku described in Sect. 14.4 was closely related to the popularity of TV entertainment. Further, Ginza's "buying" functions experienced their peak during the period of rapid economic growth in Japan, while political decisions influenced the conceptual change in Odaiba's tourism. We explained earlier that urban tourism spots are

Table 14.2 Descriptions about Odaiba in guidebooks in 1998

Attraction	Area	Distinctive expressions	No. of pages
Shiokaze park	Daiba	Sunny terrace with a wooden floor from where you can view ships going & coming	0.2
		You can see the recording environment/extraordinary view of Odaiba	
		Enjoy Odaiba's scenery	
		100m above the ground, spreading panoramic view of 270 degrees	
		Set of popular talk show "Gokigenyo"	
		Bring your camera with you and take memorable photos	
		A model exhibit of the kitchen studio of "Ryouri no Tetsujin", a popular food themed variety show	
Fuji TV	Daiba	You can see the recording environment of variety shows	1.4
		Sample exhibits of food hated by famous people	
		Display of costumes/see off by Gachapin and Mukku	
		Panoramic view of seaside including rainbow bridge	
		Italian Pizza restaurants/overlook the studio through the glass window	
		Miniature diorama recreating the city in "Sazaesann"	
		Exhibits related to popular programs	
		Selling of stuffed toys of popular characters	
Grand Pacific Meridien hotel	Daiba	Concept of eighteenth century residence	0.2
		Overlooking Rainbow bridge	
Daiba Park	Daiba	Batteries constructed in preparation for the invasion of foreign vessels in the end of Edo period	0.1
		Beautifully curved white sand beach	
Odaiba Seaside park	Daiba	Rainbow Bridge opposite the shore	0.2
		Rainbow Bridge is lit up from dusk	
Tokyo Jpypolis	Daiba	Loaded with latest attractions	0.2
		Terrace seat with a view of Rainbow Bridge just before you	
Sunset Beach Restaurant Row	Daiba	Colorful Mexican style interior	0.3
		Interial structure in an early American style	
		Terrace seat offering a close view on Odaiba Seaside Park	
Marine House	Daiba	Decorated with photos of Odaiba's old sceneries, which brings nostalgic feelings	0.3
		In front of the store, a terrace seat to enjoy the view of Rainbow Bridge	
		Orange and pink as basic tones of the stores	
		View of the Rainbow Bridge through the window	
		Ideal location/ open café	

(continued)

Table 14.2 (continued)

Attraction	Area	Distinctive expressions	No. of pages
DECKS Tokyo Beach	Daiba	Boundless feeling of Odaiba while watching Rainbow Bridge	0.7
		Shops with variety of food items from different parts of the world	
		Plenty of cute character goods	
		Take out shops of Taco and drinks	
		take out shops of rice balls	
Telecom center	Aomi	Spots designed with the concept of present and future of "mobile communication"	0.1
Symbol Promenade Park	Aomi	"Nature which brings peace of mind" as the concept	0.1
		Green fields full of nature	
		overall Interpretation of maritime affairs	
Museum of Marine Science	Aomi	Enjoy virtual reality experience	0.3
		Palm trees in the terrace	
		A place like a café in a resort area	
Aomi Frontier Building	Aomi	Also as an observatory	0.1
		View of wharf through the window	
		Search on computer about the destinations of the ships in the anchorage	
No of pages introducing Odaiba (among total of 176 pages)			4.2

Based on Rurubu Johouban Kanto 6 Tokyo '99

Table 14.3 Descriptions about Odaiba in guidebooks in 2005

Attraction	Area	Distinctive expressions	No. of pages
Fuji TV	Daiba	Enjoy stamp rally free of charge/Exhibits of studio sets and props	2.3
		Interesting exhibits of popular programs/great view on clear days	
		Booths related to latest programs/Full view of Rainbow Bridge and	
		skyscrapers of Tokyo Bay	
		The arcade up to the observation room is a masterpiece	
		Let's get projected in the TV camera/The real room of the show	
		Exhibit a model of Isono family/Sit down at an actual program booth/	
		A special menu related to TV programs	
		Showcase of signed novelties/Fuji TV trip souvenirs	
		Event spaces/view of a hanging garden	

(continued)

Table 14.3 (continued)

Attraction	Area	Distinctive expressions	No. of pages
DECKS Tokyo Beach	Daiba	Nostalgic shopping street of Daiba 1-chome/about 150 shops &	2.3
		Restaurants/Deck-style terrace by the sea	
		"Daiba small Hongkong"	
		"Daiba 1-chome shopping street" which gives you a nostalgic feeling/great view on Ranbow bridge/Ocean view along with Rainbow bridge from cafes with a great variety of foods/ cute and girlish goods	
		This year's trendy Victorian fashion goods/Japan in Showa period/ twilight townscape	
		Good old Japan's townscape/boundlessly spreading glittery sea	
		Colorful candies, bamboo works, fondly toys/street-stall style shops	
		From old-fashioned goods to fun items/cafes with the concept of lark in the beautiful sky	
		Recreation of the Kowloon city, its scenery and even the sounds	
		Improved chinese restaurants and shops	
Odaiba Seaside Park	Daiba	Odaiba Seaside Park which has a great view	0.2
		Artificial white sandy beach overlooking Odaiba's Rainbow Bridge/Sun bathing and walking	
National Mueum of Emerging Science and Innovation	Aomi	Latest science and technology/planetarium that can project numerous	1.1
		stars/Exhibits of latest technology/Exhibits related to Neutrino	
Venus Fort	Aomi	Beautiful white sandy beach/Rainbow bridge opposite the shore	2.1
		Lighting up of Rainbow bridge in the evening	
Palette town	Aomi	Latest Toyota cars/History garage of old finest cars/ finest cars of the world	1.9
		Restored finest cars/New cars of TOYOTA/ Exhibits related to various cars	
		You can see Mt. Fuji on days of good weather/night view just before you	
		Illuminated Tokyo Tower/Original goods directing for a healing lifestyle	
		Space for an amiable time/regularly 20 to 30 doggies and kitties	
		Enjoy the specially coordinated outfits/various other goods	

(continued)

Table 14.3 (continued)

Attraction	Area	Distinctive expressions	No. of pages
Museum of Maritime Science	Aomi	Theme of sea and ships with videos and real sized models, Exhibits of miniatures	0.1
Ooedo-onsenMonogatari	Aomi	Motif of edo city/17 types of baths/foot bath/sand bath/ Special pool for dogs	1.1
		Street-style food/Original Japanese food	
Aqua City Odaiba	Daiba	Restaurants with sea viewing terrace seats/Flagship store of the famous Joymark	0.6
		Design/Creation of an American style townscape/Feel an atmosphere like the West Coast of America/jackets, pants, shirts regardless of gender	
		Shop interior designed with a flavor of resorts in Southern Europe/Projection of	
		a fairytale-like atmosphere in the Aquarium at night/ beautiful night view/Competition among famous shops all around Japan	
Telecom Center Building	Aomi	Arc de Triomphe of near future/Sparkling night view of Tokyo	0.1
Tokyo Water Science Museum	Aomi	Experience various experiments/Sight seeing the Ariake Water Reclamation Center	0.1
Mediage	Daiba	Latest exhibits/projection of an unusual space/ beautiful ocean view of Odaiba	0.1
		Asian food in monsoon style/Mainly silver accessories/ Great variety of foods at reasonable prices/spacious shops remind of the European old castles in the medieval	
		Age/ Coca Cola related goods/While watching the ocean in Odaiba	
Rainbow Bridge	Daiba	Entire view of Odaiba from the observatory room	0.5
		Ahead the Rainbow Bridge is Tokyo's symbol, Tokyo Tower	
		Madder-red stained twilight time/View from the bridge is also exceptional	
		No of pages introducing Odaiba (among total of 187 pages)	13.4

Based on Rurubu Johouban Kanto 6 Tokyo '06

formed through the interrelations of tourists and local people. However, the influence of social changes on the functions of tourism spots is unavoidable. Therefore, it is important to identify the core attractiveness of an area in order to develop its urban tourism. Observation of tourist behavior can help to identify the desires of tourists in the area. Once these identified, it is then important to establish local people's openness to the developing of such attractions. When the desires of tourists and locals match, the related tourism developments can be undertaken; however, when they do not match, it is necessary to consider whether the developments of tourism attractions desired by tourists should be carried out without the consent of local people, or whether new attractions should be created for tourists that are acceptable to local people. However, tourists will not visit new attractions they perceive to be uninteresting. New attractions also require enormous investment of time and expense to generate sufficient tourist interest. Conversely, it is not always necessary or possible to adjust a tourism spot according to the desires of tourists. Most important is to maintain a balance between the desires of both parties. As tourists may not be proactive in their efforts to maintain such a balance, the authorities involved in tourism planning and development have a key role in considering ways to sustain a balance between tourists and local people.

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Chapter 15
The History of Electric Enterprises and Power Supply Development in Tokyo Since the Meiji Era

Toshiaki Nishino

Abstract This paper undertakes a detailed study of the history of Tokyo's electric industry and debates its current problems. On March 11, 2011, Fukushima Daiichi nuclear power plant, located in Fukushima Prefecture, was destroyed by a tsunami that followed the 2011 Tohoku earthquake. Due to the consequential power shortage in the Tokyo Electric Power Company's supply area, scheduled blackouts were carried out for weeks. Accordingly, Tokyo's citizens realized that a large share of the electricity they consumed had been produced by the nuclear plants located in rural areas, such as Fukushima Prefecture. Tokyo (formerly Edo) is located in the middle of Kanto Plain and has been one of the centers of Japan since the Tokugawa period (1603–1868). It became the country's capital in the Meiji era (1868–1912). Since then, as modernization progresses, it has transpired that its location poses inherent difficulties regarding the local consumption of locally produced electricity. Initially, electricity was supplied locally by thermal power generation. However, the base of power generation moved to areas outside Tokyo before World War II, when large-scale hydroelectric power plants were constructed. Moreover, after 1970, nuclear power plants were built in distant places. Consequently, Tokyo's electricity self-sufficiency rate fell from 14.6% in 1934 to only 3% in 2012.

Keywords Electricity enterprise · Electric supply companies · Tokyo City · Tokyo Electric Power Company

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15.1 The History of Electric Supply Companies in Japan Before World War II

The purpose of this paper is to clarify the history and characteristics of the electric enterprises in Tokyo. In 1882, the world's first electric supply company was established in New York in the United States (US). In 1887, Tokyo Dento[1] was established as the first electric supply company in Japan. Prior to the introduction of electricity, gas lighting had been used (since 1872) as the first stage of modern illumination in Japan. However, it did not develop further.

Before World War II, the electric power industry developed through a market-based mechanism. Despite this, not all electricity was supplied by private companies. Large-scale cities also provided electricity for the public in an attempt to acquire fiscal resources. There were cases in which the municipality administrated electric power enterprises in farming villages, in mountain villages, or on isolated islands where private companies did not supply electricity.

The success of Tokyo Dento influenced the spread of electricity use in Japan's cities. Kobe Dento was established in 1888, followed by Osaka Dento and Kyoto Dento, both established in 1889. The number of business units supplying electricity in Japan numbered 602 in 1907, 699 in 1921, and 818 in 1933. The major characteristic of Japan's electric power industry before World War II was a formation of the oligopolistic firms in a large-scale city -namely Tokyo, Nagoya, Kyoto and Osaka (Nishino 2014a, b). Tokyo Dento merged with other electric supply companies in the Kanto region to become the largest electricity supplier prior to World War II. Further, when Japan entered the conflict at the outbreak of war with China in 1937, a law was enacted enabling the national government to manage the electric supply industry in 1938. By enacting this law, Japan ended the history of free competition within the industry. Consequently, the national government took control of the electric supply industry and divided Japan into nine blocks. Even after World War II, this system was preserved. In the rest of the paper, the history of the electric supply industry in Japan's capital city is examined in greater detail, and the characteristics of electric supply and demand in the capital area are analyzed.

[1] In Japanese, "Dento" is the name of a company that supplies electricity. "Denki," in Table 15.2, has the same meaning, and "Suiryoku" indicates hydro-power.

15.2 Development of the Electric Supply Industry of Tokyo Before World War II

15.2.1 The Dawn and Growth of the Electric Supply Industry in Tokyo

Tokyo Dento was known as the organizer of Japan's electric supply industry. Many electric supply companies were established by investors who knew these businesses would be able to make hefty profits. Tokyo Dento's establishment was authorized by the government in 1883, and it began to supply electricity in 1888. The supply to the central part of (then) Tokyo City was delivered through thermal power generation by the company. The business units that supplied electricity in Tokyo Prefecture as of 1914 are indicated in Table 15.1. In 1914, there were six business units designed to supply electricity for both light and power, and five railway companies that supplied electricity to the area along the railway routes. In 1914, Tokyo Dento accounted for 74.2% of the supply of electricity for Tokyo City homes, and for 17.9% of the Tokyo Prefecture. Figure 15.1 shows the distribution of the business units' electric supply areas in Tokyo Prefecture in that year.

The Tokyo Municipal Management Electricity Supply Organization was a close competitor of Tokyo Dento in the supply of electricity. In 1880, the first horse tramway by a private management opened a business in Tokyo City. Three railway companies amalgamated and the Tokyo Electric Railway Company was established in 1906. However, the new company was boycotted by the citizens because it raised the train fares. This situation was resolved with the purchase of the railway company by Tokyo City authorities in 1911, following which it was run by public management. A notable characteristic of the electric supply business in Tokyo Prefecture is that the railway company supplied electricity to residents' homes. For another example, the Keio Electric Railway Company, incorporated in 1913, established the railway between Shinjuku Station and Hachioji Station and developed an electric supply to the area alongside the railway. Due to these developments, the diffusion of light in Tokyo Prefecture surged from 14.9% in 1910 to 63.5% in 1915 (Table 15.2).

Pre-World War II, Japanese law on the electric power industry allowed more than one business unit to supply electricity to one area. Therefore, Tokyo Dento, Tokyo City, and other electric supply companies were supplying electricity to the same area (Fig. 15.1). This unfolded as a battle between two or more electric supply business units for market gain in a city area with extensive (and increasing) electric demand.

Table 15.3 lists the power plants of the companies that supplied electricity to Tokyo Prefecture in 1914. The hydroelectric power plants of Tokyo Dento were located outside Tokyo Prefecture at this time. The electricity used in the capital city came to be transmitted from remote locations as its population continued to rise.

When the accident occurred at the nuclear plant of Tokyo Electric Power Company, following the massive earthquake on March 11, 2011, many of the capital's inhabitants came to recognize that the power plant supplying most of the

Table 15.1 Electric utility companies in Tokyo in 1914 (Nishino 2014a, b)

Electric supply company		Establishment	The main supply area	Number of demand (Number of Household)	Electric lamp (Total amount of light)	Electric horsepower (Total amount of Electric horsepower)	other (kw)
Specialize in electric supply	Tokyo Dento	1887	Tokyo City, Kita-Toshima County, Minami-Tama County	382,268	10,169,632	15,296	4324
	Nippon Dento	1913	Tokyo City	11,562	397,734	112	–
	Teikoku Dento	1913	Nishi Tama County	1907	40,852	15	–
	Edogawa Denki	1913	Minami Katsushika County	–	–	–	–
	Kinugawa Suiryoku Denki	1912	Minami Adachi County, Ebara County	–	–	–	7145
	Katsuragawa Suiryoku Denki	1913	Ebara County, Kanagawa Prefecture	–	–	–	7145
Subsidiary business	Tokyo City	1911	Tokyo City, Toyotama County, Ebara County	91,980	3,168,032	3274	238
	Keihin Electric Railway	1901	Ebara County	9964	46,137	380	–
	Tamagawa Electric Railway	1908	Ebara County, Kanagawa Prefecture	3975	99,740	136	–
	Oji Electric Tramway	1911	Kita-Toshima County, Saitama Prefecture	12,536	158,257	475	–
	Keio Electric Tramway	1913	Minami-Tama County, Kita-Tama County	906	14,261	–	–

Source: Communication Department (1915) The 7th Directory of the Electric Supply Industry

Notes:

1. Data concerning the number of homes which uses electricity in the Edogawa electricity does not exist
2. The establishment year of the subsidiary business is the year in which the supply of electricity for light began

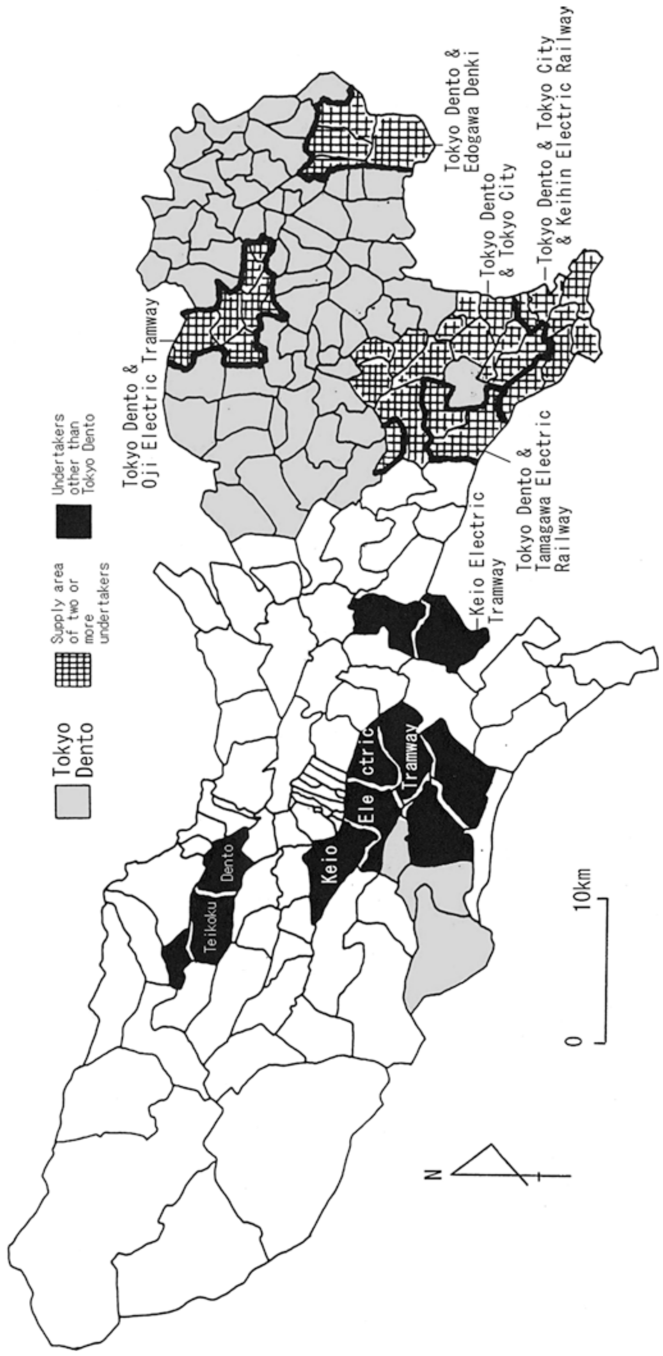

Fig. 15.1 Distribution of electric supply region in Tokyo in 1914 (Nishino 2014a, b) (Source: Communication Department (1915) The 7th Directory of the Electric Supply Industry)

Table 15.2 Transition of the popularization of electricity in Tokyo (Nishino 2014a, b).

Year	Number of household					Number of use household	Rate of light diffusion (Presumption)
	City	County	Total	Island	Total		
1890 (Meiji 23)	277,049	61,741	338,790			1130	0.3
1895 (Meiji 28)	294,456	103,192	397,648			4347	1.1
1900 (Meiji 33)	355,517	106,197	461,714			6996	1.5
1905 (Meiji 38)	485,024	122,141	607,165			15,424	2.5
1910 (Meiji 43)	466,164	164,995	631,159	7057	638,216	94,790	14.9
1915 (Taisho 4)	581,707	222,417	804,124	10,467	814,591	517,277	63.5
1925 (Taisho14)	429,852	535,920	965,772	7835	973,607	943,847	96.9
1930 (Showa 5)	414,630	703,231	1,117,861	7912	1,125,773	1,096,833	97.4
1935 (Showa 10)	437,130	836,970	1,274,100	8603	1,282,703	1,265,717	98.7

Sources: Tokyo Prefecture statistics book; Tokyo Electric Power Company (2002) Electric power industry in the Kanto district and Tokyo Electric Power Company

Note: There is no data of island in Tokyo Prefecture before 1910

Table 15.3 List of power plants of electric utility companies headquartered in Tokyo in 1914 (Nishino 2014a, b)

Location	Electric Supply Company	Prefecture	Name of electric power station	Motive force	Start up	Output power (kw)	Purpose		
							Electric lamp	Electric power	Electric railway
Tokyo within the prefecture	Tokyo Dento		Asakusa	steam power	1895	6100.0	○	○	
	Tokyo City		Fukagawa	steam power	1905	6120.0	○	○	○
	Tokyo City		Shibuya*	steam power	1905	3600.0	○	○	○
	Tokyo Dento		Senju	steam power	1905	3500.0	○	○	
	Oji Electric Tramway		Sugamo*	steam power	1911	500.0	○	○	○
	Edogawa Denki		Kasai	gas power	1913	60.0	○	○	
	Keio Electric Tramway		Fucyu	gas power	1913	52.2	○	○	○
	Tokyo City		Shinagawa	steam power	no date	4400.0	○	○	○
Tokyo out of the prefecture	Tokyo Dento	Yamanashi	Komahashi	hydraulic power	1907	15,000.0	○	○	
	Tokyo Dento	Yamanashi	Yatsuzawa	hydraulic power	1912	19,800.0	○	○	
	Katsuragawa Denryoku	Yamanashi	Shikadome	hydraulic power	1913	12,000.0		○	
	Kinugawa Suiryoku Denki	Tochigi	Shimotaki	hydraulic power	1913	24,000.0		○	

Sources: Communication Department (1915) The 7th Directory of the Electric Supply Industry; Tokyo Electric Power Company (2002) Electric power industry in the Kanto district and Tokyo Electric Power Company

Note: *Preliminary Power plant

electricity to Tokyo was in Fukushima Prefecture. Tokyo Dento originally constructed the hydroelectric power plant outside Tokyo Prefecture because there was no river suitable for hydro-power around the capital. Thus, the area's characteristic self-insufficiency had already appeared before World War II.

15.2.2 Rapid Progress of the Electric Supply Industry in Tokyo

The period from 1908 to 1922 saw rapid advancement in Japan's electric supply industry (Miyake 1951). Major Japanese industries before World War II were the cotton spinning and silk reeling industries. The cotton spinning industry had developed through the expansion of the national market and exports to China began in 1890. The silk reeling industry increased its export volume after 1895, and 70% of the raw silk produced in 1910 was exported to the US (Hanai 2000). The development of these light industries changed the motive power of the factory from steam engine to electricity, and the proportion of electric motor power in the total horsepower on the motive power reached 51.3% in 1917 (Kamibayashi 1948).

In contrast, the rate of electricity penetration in homes was only 2% in 1907. It increased dramatically with economic growth, reaching 42% in 1917 and 87% in 1927, respectively. Per capita candlepower rose from 0.82 in 1912 into 7.72 in 1925. The speed of the diffusion of light in Tokyo Prefecture homes was faster than that at the nationwide level, and the penetration rate in 1915 reached 63.5%.

15.2.3 The Competition Between Electric Supply Companies and State Management of Electric Power

Figure 15.2 presents the distribution of the electric supply areas of Tokyo Prefecture in 1938, when the nation government enacted the law enabling it to control electric power. At this point, though all municipalities in Tokyo Prefecture already had coverage, electricity was not available in all houses in Tokyo Prefecture. Tokyo Dento had expanded the electric supply area to rural regions, while at least two electric supply companies supplied electricity in the urban area. For example, Tokyo Dento and the Keio Electric Railway Company were supplying electricity in the west area of Tokyo City. In addition, small-scale electric supply companies established by local investors were located in farm villages and mountain villages of west Tokyo Prefecture. Moreover, electricity was also supplied from electric supply companies headquartered in other prefectures. Tokyo Dento constructed hydroelectric power plants in the upper reaches of rivers outside Tokyo Prefecture as the electric demand increased further. In addition, Tokyo Dento purchased several hydroelectric power plants in those regions (Nishino 2012). Thus, Tokyo Dento came to dominate hydropower around Tokyo Prefecture.

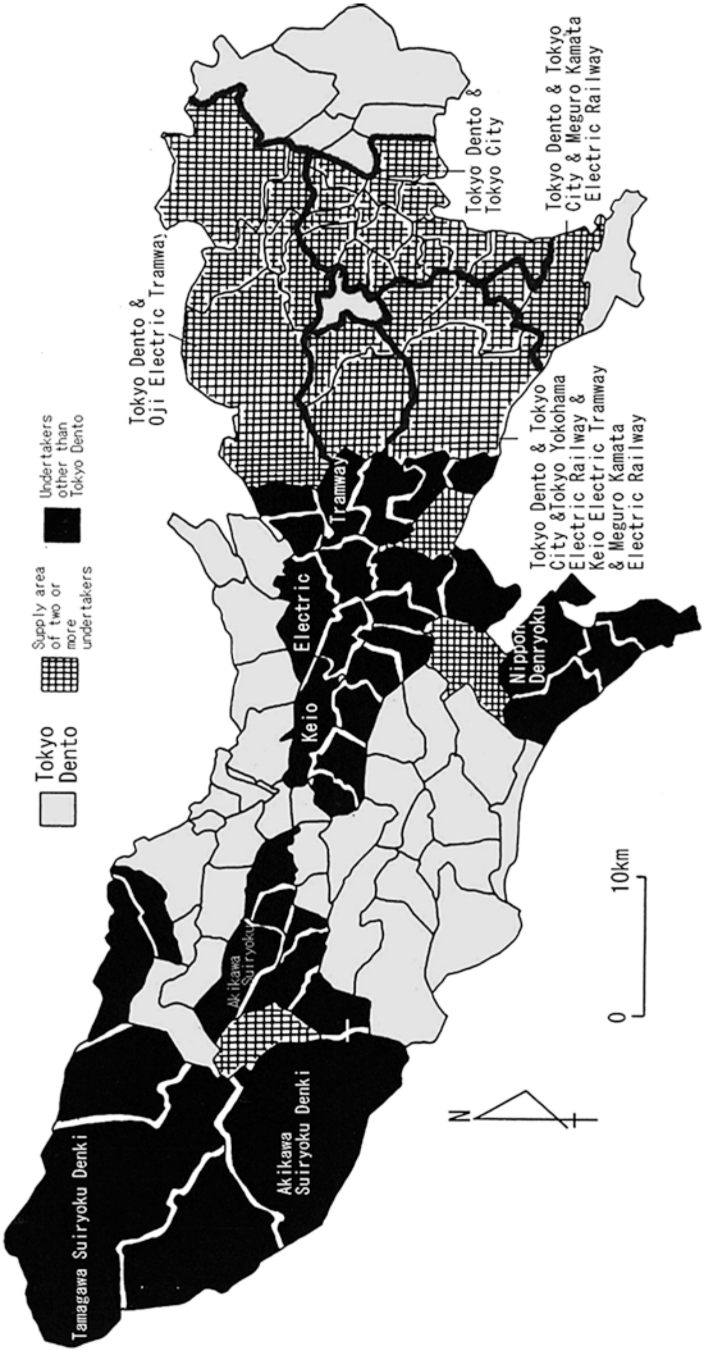

Fig. 15.2 Distribution of electric supply region in Tokyo Prefecture in 1938 (Nishino 2014a, b) (Source: Communication Department (1939) The 30th Directory of the Electric Supply Industry)

The expansion of Tokyo Dento's power generation area became possible through the development of power transmission technology. For example, because there were 227 km between Tokyo City and Inawashiro of Fukushima Prefecture, where electricity was generated, power was transmitted at high voltage (154,000 volts). Thus, at this point in history, the city's power supply could be secured from remote locations with the development of high-voltage power transmission technology. Consequently, Tokyo Dento's finances were strong during this period. The company's dividend rate was 9% in the first half of 1914 and 10% in the latter half; in 1918, it reached 12%, before climbing to 14% in 1922.

In contrast, the Tokyo Municipal Management Electricity Supply Organization, which administered both the supply of electricity and management of the tram, recorded a loss due to competition between electric supply companies until 1917. Typical price competition was observed among those companies, but charges within Tokyo City were united by the agreement of Tokyo City and other electric supply companies in 1917, thus ending this competition. Consequently, the condition of the Tokyo Municipal Management Electricity Supply Organization greatly improved and it performed strongly, except in 1923, when a massive earthquake damaged the city. Its management of the tram was also steady, and the profit from that business became an important fiscal resource of Tokyo City authorities (Nishino 2012).

As stated above, small-scale electric supply companies were established in the mountain villages by local capitalists. Because demand was small, large-scale electric supply companies had not entered those areas. Consequently, the energy system for local consumption depended mainly on small-scale hydro-power. For example, the scale of a small-scale hydroelectric power plant of Hikawa Denki, established in 1916, was the head drop of 54.55 m, and its maximum power was 12.5 kw. The shortfall in the amount of electricity this company could supply was met by purchasing from other electric supply companies.

The penetration rate of light in Tokyo Prefecture's homes was estimated to be 98.7% in 1935 (Nishino 2014a, b). Table 15.4 shows the amount of electricity use and the total power generation amount of the electric supply companies in Tokyo Prefecture, alongside the self-sufficiency rate, which was 10.3% in 1919 and 15% in 1931. Thus, most of the electricity used in Tokyo Prefecture was produced by power plants located outside Tokyo.

Figure 15.3 shows the development and transition of the power generation of electric supply companies headquartered in Tokyo Prefecture. The power supply depended initially on thermal power generation, as Tokyo City had developed into the waste plain parallel to Tokyo Bay. Hydro-power generation matched the level of thermal power generation in 1909, after which the amount of hydro-power generation overwhelmed thermal power, reaching 80% in 1938.

Table 15.5 shows the total power generation amount in each area of electric supply companies headquartered in Tokyo Prefecture in 1934. The amount of power generation in Yamanashi Prefecture was the largest, while that of Tokyo Prefecture was 14.6%. Thus, about 85% of the electricity used in Tokyo Prefecture was generated outside the prefecture, as it lacks a powerful hydro-power base. Many of the electric supply companies of Tokyo Prefecture developed their power supply in

Table 15.4 Trends of electric demand in Tokyo and the electricity self-sufficiency rate in the region (Nishino 2014a, b)

Year	Amount of use of electricity of Tokyo			Amount of power generation of Electric Company in Tokyo		Ratio of self-sufficiency of electricity in Tokyo Prefecture
	Electric lamp(kw)	Electric power(kw)	total	Gross of output power (kw)	Amount of power generation of Power plant located in Tokyo within the prefecture	
1919 (Taisho8)	44,133	138,080	182,213	276,552	31,735	10.3
1921 (Taisho10)	59,248	170,036	229,284	313,483	31,735	9.2
1924 (Taisho13)	99,924	139,616	239,540	482,259	26,590	5.2
1927 (Showa2)	145,051	213,811	358,862	650,901	104,080	13.8
1931 (Showa6)	196,334	530,554	726,888	646,854	114,393	15.0

Sources: Communication Department: The 7th Directory of the Electric Supply Industry (Each year from 1919 to 1931); Tokyo Electric Power Company (2002) Electric power industry in the Kanto district and Tokyo Electric Power Company

Note: The use amount data of light and the electric power is sourced from Kurihara (1964, p. 184)

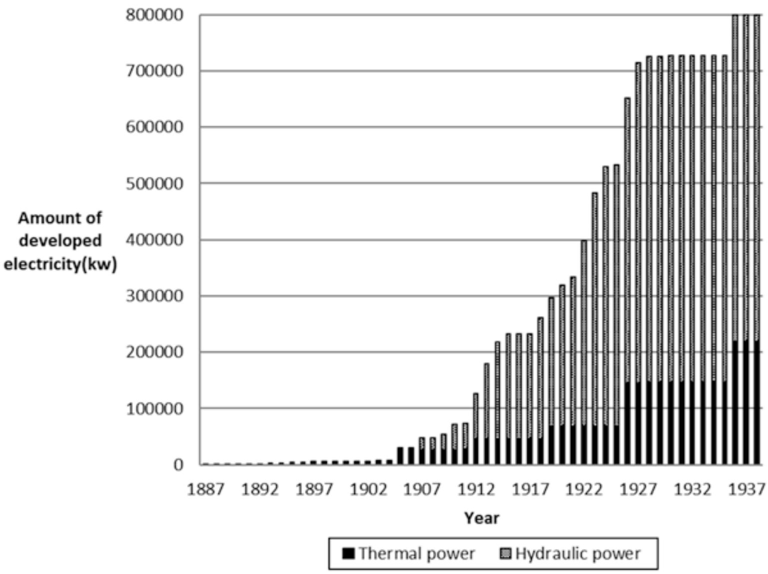

Fig. 15.3 Power supply developed by electric utility companies in Tokyo every year before World War II (Nishino 2014a, b) (Sources: Communication Department: The Directory of the Electric Supply Industry (Each year from 1919 to 1931); Communication Department (1937) List of permitted locations for hydroelectric power plants; Tokyo Electric Power Company (2002) Electric power industry in the Kanto district and Tokyo Electric Power Company)

Table 15.5 Amount of power generated by power plants located in other prefectures of electric power companies headquartered in Tokyo Prefecture (1934) (Nishino 2014a, b)

Prefecture	Gross of output power (kw)	Ratio
Yamanashi	208,615	26.6
Tokyo	114,390	14.6
Kanagawa	104,482	13.3
Fukushima	97,200	12.4
Niigata	75,600	9.7
Gunma	63,410	8.1
Tochigi	55,334	7.1
Nagano	33,700	4.3
Shizuoka	22,120	2.8
Saitama	5800	0.7
Aichi	2619	0.3
Ibaraki	–	–
Chiba	–	–

Sources: Communication Department: The Directory of the Electric Supply Industry (Each year from 1909 to 1934); Tokyo Electric Power Company (2002) Electric power industry in the Kanto district and Tokyo Electric Power Company

Yamanashi, Kanagawa, Fukushima, Niigata, and Gunma Prefectures. When nuclear power generation was developed after World War II, this supply structure of energy Japan's capital was retained.

The number of business units supplying electricity was 731 in 1937, when the Japanese government rushed into the war regime, enacting the law enabling the nation to control the entire electric power industry in 1938. Finally, all electric supply companies were integrated in 1943, and the government established statutory corporations in nine area blocks. Even after World War II, that framework of the nine area blocks was retained.

15.3 Establishment of Tokyo Electric Power Company and the Development of Large-Scale Power Generation

15.3.1 The Birth of the Nine Electric Power Companies

The system of electricity supply by statutory corporations was dismantled by the Potsdam in November 1950. Accordingly, the government established nine electric power companies integrating power generation with power transmission in 1951. Thus, the nine post-war electric power companies were founded based entirely on the nine pre-war statutory corporations. Tokyo Electric Power Company acquired responsibility for the supply of electricity in the Kanto region, including the capital city.

15.3.2 The Progress of Electric Power Development in Tokyo After World War II

The Act for Comprehensive Development of the National Land was enacted for the reconstruction and economic development of Japan in 1950. Many large-scale dams, for generating electric power, were constructed on the upper reaches of the main rivers by the national policy corporation (J-Power). For example, a large-scale dam and hydroelectric power plants were constructed in the interior of Fukushima Prefecture, and electricity was transmitted from there to Tokyo. After the war, hydro power was the major power source in Japan until 1959. By the mid-1950s, a large amount of electricity was needed as the population of the metropolitan area increased and industrial development accelerated. Therefore, thermal power plants were constructed along Tokyo Bay, beginning the age of thermal power. However, the frontier of energy development moved to nuclear power after 1973, as Japan's economy stagnated due to the surging petroleum price. Environmental problems caused by thermal power also drove the shift to nuclear energy.

Figure 15.4 presents the transition of the electric power development of Tokyo Electric Power Company. As noted above, thermal power generation with coal or oil was mainly developed post-war, but use of nuclear power rose after 1970. In 1959, thermal power reached 52.3% of the total amount of the company's power generation. In 1980, the ratios of thermal, nuclear, and hydro power generations were 74.7%, 14.8%, and 10.6%, respectively. In 2010, the respective ratios had become 59.5%, 26.6%, and 13.8%; the share of new energy (wind power and sunlight) was 0.4%.

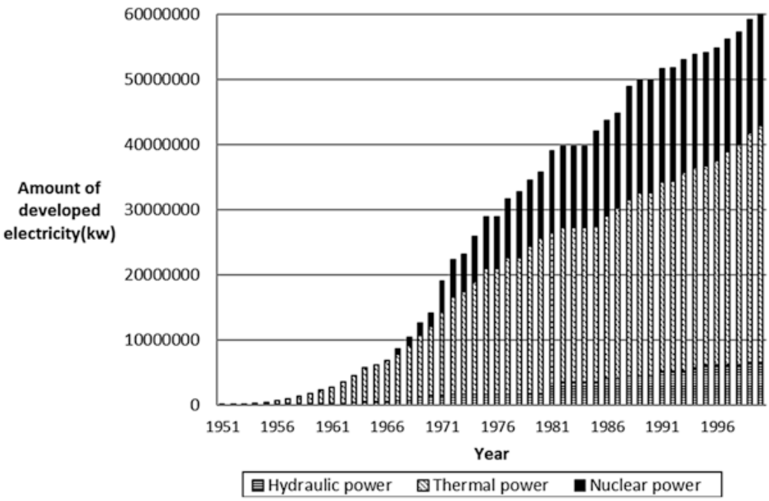

Fig. 15.4 Power supply development by Tokyo Electric Power Company every year after World War II (Nishino 2014a, b). (Source: Tokyo Electric Power Company (2002) Electric power industry in the Kanto district and Tokyo Electric Power Company)

Table 15.6 shows the of the company's electricity sales in each prefecture. In total, Tokyo Electric Power Company was supplying electricity to a population of 44.73 million, and the amount of electric power it supplied totaled 303.4 billion kWh. Tokyo Metropolis accounted for 27.3% of sales.

Focusing on the areas for which Tokyo Electric Power Company is responsible for supplying electricity, Table 15.7 details the maximum power generation of each business unit in each prefecture in 2012. According to the table, the share of Tokyo Metropolis was only 3%.

The area with the largest power generation is Chiba Prefecture, which is adjacent to Tokyo Metropolis. It accounts for 23.9% of the total and is mostly thermal. Ranked second is Fukushima Prefecture: power generation there accounts for 20.81% of the whole of TEPCO, and nuclear power accounts for 58.3% of the amount of the power generation of this area. The power generation in Kanagawa Prefecture, which is also adjacent to the Tokyo Metropolis, is 15.81% of the total. Furthermore, that of Niigata Prefecture, which is 300 km away from Tokyo Metropolis, is 13.75%. Evidently, the larger suppliers are located both near to and far from Tokyo Metropolis. Their locational characteristics are such that thermal power plants are close to Tokyo Metropolis while nuclear power plants are in areas far from Tokyo. Note that the distance between the points of power generation and consumption should be short to as the power transmission cost increases with distance.

The location of thermal power plant is typically based on the following criteria: cheap land, small distance to both the demand area and the port of entry for importing fuel, and water access. Consequently, many thermal power plants are located along Tokyo Bay, near the capital city.

In contrast, the location of a nuclear plant needs to satisfy the following conditions: bedrock near the earth's surface, historically low frequency of earthquakes, (sea) water access, a non-inhabited area, and (desirably) a short distance to the

Table 15.6 Electric demand (and ratio) in each prefecture under the jurisdiction of Tokyo Electric Power Company in 2010 (Nishino 2014a, b)

Prefecture	Population (in ten thousand)	The sales quantity of electricity (in hundred million kWh)	Ratio
Tokyo	1307	828	27.3
Kanagawa	909	526	17.3
Saitama	720	400	13.2
Chiba	625	392	12.9
Gunma	206	170	5.6
Tochigi	202	178	5.9
Ibaraki	297	364	12.0
Yamanashi	85	65	2.1
East part of Shizuoka	122	111	3.7

Source: Tokyo Electric Power Company

Table 15.7 Maximum power generation (and ratio) in each region supplied by Tokyo Electric Power Company (January 2012) (Nishino 2014a, b)

Company	Tokyo Electric Power Company			J-Power		Japan Atomic Power Company	Tokyo Hatsuden	Prefecture	Private power generation company		
Prefecture	Hydraulic power	Thermal power	Atomic power	Hydraulic power	Thermal power	Atomic power	Hydraulic power	Hydraulic power	Thermal power	Total (kw)	Ratio
Tokyo	8250	2,201,100	–	–	–	–	–	36,500	–	2,245,850	3.00
Kanagawa	45,590	10,249,000	–	–	1,200,000	–	7960	354,630	–	11,857,180	15.81
Chiba	–	17,006,000	–	–	–	–	650	–	917,765	17,924,415	23.90
Saitama	–	–	–	–	–	–	53,650	–	–	53,600	0.07
Gunma	2,436,470	–	–	–	–	–	12,670	246,552	–	2,695,692	3.60
Tochigi	2,206,060	–	–	675,000	–	–	–	60,630	–	2,941,690	3.92
Ibaraki	–	5,400,000	–		–	1100,000	17,810	–	1100,000	7,617,810	10.16
Yamanashi	1,054,420	–	–	–	–	–	12,180	119,497	–	1,186,097	1.58
Shizuoka	–	–	–	–	–	–	29,315	–	–	29,315	0.04
Nagano	2,501,060	–	–	11,200	–	–	2400	–	–	2,514,660	3.35
Fukushima	353,930	3,800,000	9,096,000	2,354,300	–	–	–	–	–	15,604,230	20.81
Niigata	368,800	–	8,212,000	1,685,100	–	–	46,500	–	–	10,312,400	13.75

Sources: Tokyo Electric Power Company, J-Power, Japan Atomic Power Company, Tokyo Hatsuden, each prefecture's Industrial Policy Bureau, Tokyo Me-tropolis traffic bureau, and individual company records

Notes:

1. The author totaled this data based on each publication
2. Tokyo Hatsuden is a related company of Tokyo Electric Power Company
3. A traffic bureau in Tokyo operates a hydroelectric power plant for electric railways that Tokyo Metropolis manages

demand area. Thus, the nuclear plants of Tokyo Electric Power Company were constructed in areas with little population on the coast.

Tokyo Electric Power Company started running the Fukushima nuclear plant in 1971 and the Kariha nuclear plant (Niigata Prefecture) in 1985. The government enacted the law for the promotion of the location area of the nuclear plant in 1973. Under this law, the national government pays a grant to the municipality in which a nuclear, thermal power, or hydroelectric plant is constructed. This law is often justified as correcting regional disparity in Japan. However, a municipality loses independence when it receives a grant. Furthermore, after a nuclear plant is constructed, an area's industrial structure changes, from traditional agriculture and fishery to such industries as power plant maintenance.

The amount of power generation in Tokyo Metropolis was only 3% in 2012, though its electricity consumption accounts for 27.3% in the area covered by Tokyo Electric Power Company. As stated above, when the amount of electricity use was small, the region's energy structure was characterized by local consumption of locally produced electricity. However, when the amount increased, power plants that can generate large quantities came to be constructed outside the area. As power transmission at high voltage became possible at the beginning of the 1900s, hydroelectric power plants were constructed outside Tokyo Prefecture, following which the capital city had to depend mostly on power supply from outside the area World War II. After the war, this structure was further reinforced by the construction of large-scale hydroelectric power plants and nuclear plants of outside Tokyo.

15.4 Consideration of the Electric Power Company Problems After the 2011 Tohoku Earthquake

The core meltdown in the Fukushima Daiichi (first) nuclear plant of TEPCO, which occurred after the massive earthquake on March 11, 2011, was the most serious nuclear accident ever experienced by Japan. The hydrogen explosion in the nuclear reactor diffused radioactivity to a wide area of East Japan. To avoid radiation exposure, the officially ordered the evacuation of people living close to the nuclear plant.[2] Because power generation by the nuclear plant became impossible, and the amount of available electricity was insufficient to satisfy demand, TEPCO announced scheduled blackouts. Accordingly, train services of the railway companies ware discontinued. The accident caused the people living in Tokyo Metropolis to learn that their electricity was supplied from Fukushima Prefecture. The Tokyo Metropolitan Government conducted the projects of "Thank you for Fukushima Prefecture" to

[2] Japanese Government ordered the inhabitant the evacuation on April 22, 2011. The range of the area is as follows: area of 30 km in radius from nu-clear plant, and area with high radiation level which exceeds 30 km in radius. The pollution area by the radioactivity exceeds 8000 km^2, among those, the evacuation order area is about 1100 km^2, and, the person who had to do the evacuation reached 85,000 people.

Fukushima Prefecture, providing, for example, subsidies to cover evacuees' travel costs, shelters for evacuees, or offering jobs, such as teaching, at the elementary schools of Tokyo Metropolis.

Japan's electric power policy became a political problem, as following this nuclear power accident, and many people began to doubt the safety of nuclear power. The extraordinarily high salaries of the president of TEPCO were also questioned, as the company is a public-interest business unit. With all expenditures essentially added to the bills of Japanese consumers, it came to be argued that the electric power companies have not made sufficient efforts to ensure appropriate management. Therefore, TEPCO did not have to do the effort of the management while a lot of enterprises except the electric power industry company were continuing reductions in cost. The lax attitude of management is more likely to be formed within a system of areal monopoly in which business rivals do not exist (Nishino 2013).

Discussions concerning the electric power industry after the nuclear accident can be summarized as follows: (1) the use of renewable energy is a necessity; (2) power generation and power transmission must be separated and the regional monopoly dismantled; (3) the local consumption of locally produced energy is another necessity; (4) a social system should be constructed to democratically select power supply sources; and (5) the development of energy conservation projects and economizing electric power should both be promoted.

The Japanese Government has executed reforms corresponding to all of these matters. In 2012, the Japanese Government enacted a system under which electric power companies must buy renewable energy at a fixed price. Various enterprises work on photovoltaic generation by this system, and the diffusion of renewable energy has somewhat progressed. In 2015, the Electric Utility Industry Law was revised to reform the industry. The following reforms will be advanced by this revision. In April 2015, the government established the organization for the flexible exchange of electricity in a large area cover the nine electric power companies. In April 2016, sales of electricity were liberalized. Most fundamentally, the power transmission and the supply of electric power of the nine electric power companies will be separated by April 2020.

Following the liberalization of electricity sales, the entry of companies from other industries into the electric sales market has been remarkable. A textbook example is cellular phone companies entering photovoltaic generation. There are also enterprises without power generation equipment that buy large amounts of electricity from the electric power companies to then sells on to end users. Municipalities selling renewable energy have also appeared.

The enterprises and municipalities that entered the electric power industry following its liberalization depend on the purchase system of renewable energy: such businesses are not sustainable if the purchase price of renewable energy falls. The main purpose of liberalizing electricity sales is to destroy the system of monopoly of the electric power companies. Its second purpose is for electric sales enterprises to compete, increasing pressure for electricity price cuts. New electric sales companies offer consumers various options. Consequently, many consumers have recognized sales liberalization as a trigger for price-cut battles. However, what was actually reformed?

On the one hand, the number of entrepreneurs who have obtained authorization to sell electricity was 266 as of April 2016(2016.4.1 Asahi News Paper, Tokyo). On the other hand, only 0.5% of consumers have actually changed their electricity supplier (2016.4.1 Asahi News Paper, Tokyo). This shows the degree of people's concerns regarding the liberalization of electricity sales. The structure of Japan's electric power industry has not, so far, changed through the liberalization of electricity sales. The government refused to change the basic framework of the areas for which each of the nine electric power companies (established in 1951) is responsible, and it is again possible to promote nuclear power as a base power supply. In addition, all costs concerning power generation, power transmission, and business are reflected in the electric rate in Japan. Therefore, the electric power company does not need the management effort. In short, the character of the nine electric power companies, which used to be national statutory corporations, has hardly changed.

The author is currently researching the general history of Japan's electric power industry before World War II, focusing particularly on the electric power industry administrated by local governments. In 1891, Japan's first publicly owned power supply industry began operating in Kyoto City. In 1911, the municipalities of Tokyo City and Sendai City began supplying electricity, followed by the municipalities of Kobe City in 1917 and Osaka City in 1923. Financial support from the national government to local governments before World War II was insufficient. These cities' authorities also operated trams in addition to supplying electricity. To obtain the fiscal resources necessary to manage their respective cities, these local governments supplied electricity and tram services. The profit generated by these businesses was transferred to the general account of each municipality.

In contrast, the electric power industry was managed by prefectural governments in Kochi, Toyama, Miyagi, Yamaguchi, Aomori, and Miyazaki Prefectures. Each prefecture was able to obtain stable revenue by administrating electric power enterprises. For example, Toyama Prefecture, which started its business in 1921, needed considerable amounts of money to prevent a river flooding: therefore, to finance its river project, it developed the business to sell electricity wholesale to the electric supply companies within the prefecture. Furthermore, Yamaguchi Prefecture, which began its business in 1924, purchased all of the electric supply companies in the area, cut the price, and introduced standardized electric rates. Having begun its business in 1934, Aomori Prefecture purchased the area's main electric supply company and conducted the electrification of the agricultural area through that business's earnings (Nishino 2016).

It used to be common for publicly owned power supply enterprises to return profit to the area. The profit enriched the finance of the prefecture. However, the profits of the electric power industry in Japan today are not returned to the supply areas; instead, the electric power companies pay high wages to their managers and employees and distribute high dividends to their shareholders.

Population decline is now observed many regions of Japan, and the decrease in the fiscal revenue of each municipality. This tendency becomes more remarkable in distant regions. In principle, the national government should treat all areas equally. To form a steady fiscal base, the administration should reconsider introducing a publicly owned power supply enterprise for each prefecture or city. With Japan entering a period of population decline, it is not an appropriate time for the electric power industry to be organized through competition among enterprises under the market mechanism. The electric power industry is a business with high profitability. If each municipality manages the profit of the electric power industry, it becomes a stable revenue source. Japan's citizens should consider the development of energy autonomy, under which the method of power supply is democratically selected. It should be remembered that, historically, some Japanese mountain villages had no electricity supply before World War II, and until 1974, their inhabitants bore the cost of constructing the power plant.

Due to the decline in population, electricity consumption will fall in the future. Therefore, discussion over forming a democratic energy-oriented society is more important than focusing on liberalizing electricity sales. The history of the pre-World War II electric power industry in Japan offers many hints in considering modern energy problems.

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Chapter 16
Analysis of Current Municipal Solid Waste Management in Tokyo and Future Prospects

Hideaki Kurishima

Abstract Waste is an unavoidable problem when discussing an urban space. To understand the urban space of Tokyo, it is important to understand how Tokyo has addressed the waste problem. This chapter examines the current conditions of and future prospects for managing municipal solid waste (MSW) separately considering the central special wards area and the Tama area. In the central special wards area, the Tokyo Metropolitan Government built a waste management system based on the district self-sufficiency principle ("disposing of your own waste in your own ward"), which was established following the "Garbage War" in the 1970s. However, this system changed greatly after responsibility for MSW management shifted to each special ward in 2000. In the Tama area, municipalities established waste management systems that aimed to dispose of waste appropriately, against the background of urbanization in the 1960s. However, municipalities were compelled to shift to a form of management that reduces waste, as the remaining life of final disposal sites decreased significantly and conflicts with neighboring residents arose in the 1990s.

Keywords Municipal solid waste · Waste management · Incineration plant · Special wards area · Tama area · Tokyo

16.1 Introduction

The issue of waste is an unavoidable problem when discussing an urban space. This is because wastes, including solid waste, air pollutants, waste heat, and wastewater, are the results of the massive input of resources and energies for sustaining urban economic activities and civil life. Such wastes impose a burden on the environment and sometimes threaten people's living environment. In cities, it is, thus, necessary to establish and maintain a system to properly manage and treat waste. Of all the

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waste management systems, the most familiar to the average citizen is solid waste management. Arguably, the history of cities is the history of waste management.

Tokyo is no exception, having faced waste issues since the time it was called Edo. The *Edo bakufu,* the Japanese feudal government from 1603 to 1867, managed wastes publicly. For example, in 1655, they prohibited the illegal dumping of waste, and designated Eitaiura (near the modern-day Tomioka Hachiman Shrine in Koto Ward) as the official dump site, thus establishing the landfill disposal system (Ishikawa 2000). From that point to today, Tokyo's solid waste has always been disposed of in Tokyo Bay. Conversely, as various media have previously mentioned, Edo was active in various recycling activities (Hosomi 2015). For example, food wastes and human excreta were utilized as fertilizers in nearby farms, and such biomass recycling between urban and rural areas continued until the 1960s. However, the rapid economic growth in the 1960s engendered rapid urbanization and changes in lifestyle, with waste characteristics also changing. Consequently, the recycling relation between the urban and rural areas was severed, and Tokyo began to face various waste issues. Examining how Tokyo dealt with such waste issues is vitally important in understanding Tokyo's urban space.

Therefore, this chapter examines the current conditions of and future prospects for the managing of municipal solid waste (MSW), separately considering the central special wards area and the Tama area.

16.2 Waste Management in the Special Wards Area

16.2.1 "Garbage War" and "The District Self-Sufficiency Principle"

Presented below is a discussion on waste management in the special wards area before and after the transfer of MSW management to each ward in April 2000. However, the Bureau of Public Cleaning, Tokyo Metropolitan Government (2000) has already produced a detailed history of MSW management, from the passing of "the Waste Cleaning Act" (*Obutsu Souji Hou*)[1] in 1900 to the reassignment of MSW management in the special wards area. Therefore, this section focuses especially the "Garbage War" in the 1970s and the "district self-sufficiency principle" which emerged from this experience.

During the period of rapid economic growth from the 1950s to the 1960s, the amount of MSW generated in the special wards area rapidly increased. The amount of waste generated in 1971 was 6.8 times the amount in 1954, when the rapid economic growth period started (Fig. 16.1). During this time, the landfill sites designated

[1] This act states, "based on this act and other acts, the city… has the responsibility of cleaning the waste and maintaining a clean environment in its territory" (Sect. 16.2); it designated the municipal governments as responsible for human waste and MSW management. Tokyo city's MSW management also started from this law.

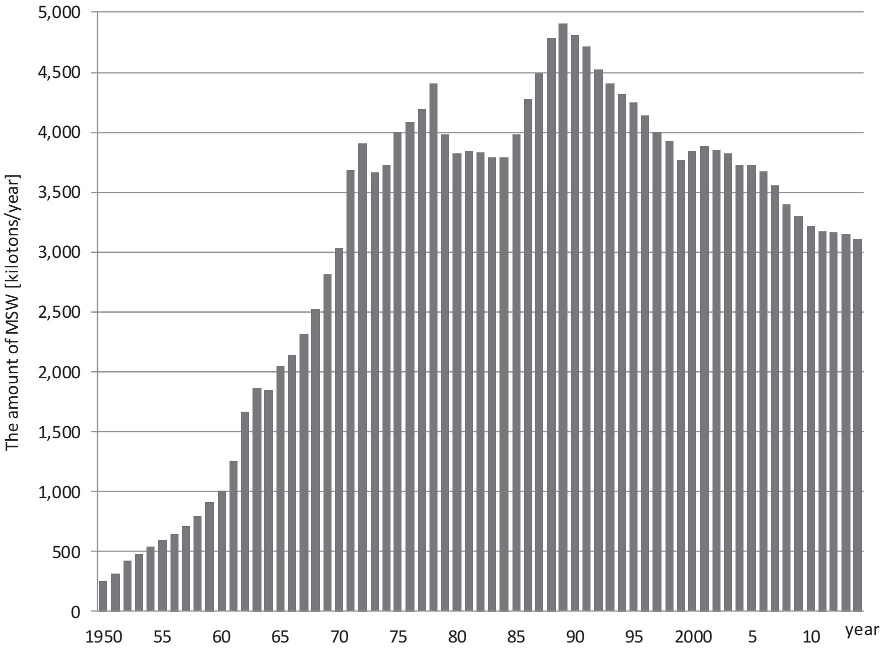

Fig. 16.1 Changes in the amount of MSW in the special wards of Tokyo, 1950–2010 (Source: Bureau of Public Cleaning, Tokyo Metropolitan Government (2000) and Ministry of the Environment, Japan (2014) (Kurishima 2014))

for the special wards were in Shiomi (1927~62), Yumenoshima (1957~66), and Wakasu (1965~74), which were all within Koto Ward. About 5000 waste collection vehicles travelled to Koto Ward from the other wards every day.

It should be noted, here, is the low rate of actual incineration of combustible waste within the special wards area during this time. In the late 1960s, the incineration rate for combustible waste in Japan was approximately 50%. While Osaka City was incinerating well over 60% of its combustible waste, the special wards area was burning less than 40% (Namie 2009). Due to this fact, significant amounts of food wastes were directly dumped in the landfill site, generating swarms of rats and flies, together with a considerable volume of methane gas, thereby worsening the living environment of Koto citizens. As presented in Fig. 16.2, the operational incineration plants in 1971 were the 11 sites in Kamata, Nippori, Osaki, Chitose, Shakujii, Itabashi, Adachi, Katsushika, Edogawa, Kita, and Setagaya. However, these plants were unable to respond to the rapidly increasing amount of MSW; therefore, much of it had to be directly disposed of in the landfill site.

In response to this situation, the Tokyo Metropolitan Government formulated a plan to build plants to incinerate all combustible waste; however, their construction stalled with opposition from local residents, who considered the proposed incinerators to be nuisance facilities. For example, disputes relating to the Suginami incineration plant's construction continued from the announcement of the construction

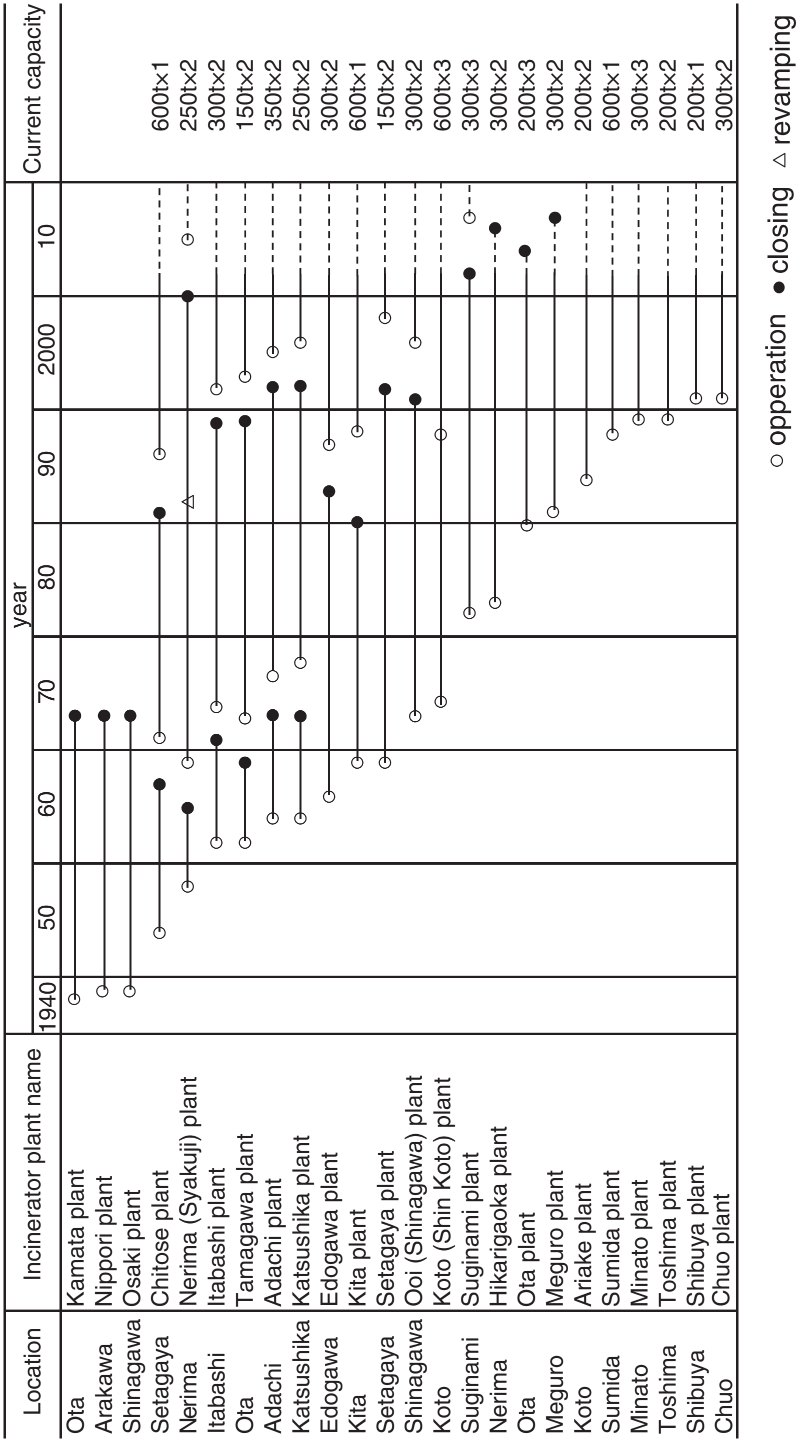

Fig. 16.2 Construction and operation of MSW incineration facilities in the special wards of Tokyo, 1945–2020 (Source: Bureau of Public Cleaning, Tokyo Metropolitan Government (2000) and Data of Clean Association of TOKYO23 (Kurishima 2014))

plan in 1966 until mediation by the Tokyo District Court in 1974. Construction only began in 1978 and the plant finally started operating in 1982.

In 1971, with the rapidly increasing amount of MSW, coupled with the delays in building incineration plants, the Tokyo Metropolitan Government approached Koto ward regarding the possibility of extending plans to use the Wakasu landfill site until 1975. Originally, the site had been due to close in 1970, but its use had already been extended to 1973. Koto Ward Council rejected this extension request, sending an open letter to the Tokyo Metropolitan Government and the other 22 wards with the message advocating the "district self-sufficiency principle," which states "waste generated in your own ward should be disposed of in your own ward," and promotes "equitable sharing of nuisance." Confronted by this situation, then Tokyo Metropolitan Governor Minobe declared "Garbage War" in the metropolitan assembly, and committed to work on resolving the waste issues. However, the situation did not improve quickly, and the dissatisfaction of Koto Ward increased. When Suginami's citizens obstructed the construction of Suginami incineration plant in 1971 and 1973, Koto citizens and the mayor physically prevented waste imports from Suginami Ward. Consequently, the Tokyo Metropolitan Government decided to follow the path of district self-sufficiency as its strategy for handling the "Garbage War"; though implementing this process progressed slowly, they finally reached a resolution by establishing plants in accordance with this principle (see Fig. 16.2). However, many of the plants built in the 1970s and 1980s were located in the peripheral wards, and while the peripheral wards treated their own wastes, the central wards were asking the peripheral wards to also accept their waste (Ishii 1989).

The amount of MSW plateaued as the economy slowed down, due to the impact of two oil crises in the 1970s, but in the late 1980s, during Japan's bubble economy, the amount of waste started to increase once again. With this increase and with the district self-sufficiency principle continuing to be promoted, many new incineration plants were built in the 1990s in the wards that did not have such plants before: these were the plants in Meguro (1991), Sumida (1998), Minato and Toshima (both in 1999), and Shibuya and Chuo Wards (both in 2001). Shinjuku, Arakawa, and Nakano Wards, where they had not constructed, planned to establish theirs from 2006 to 2011. In addition, in the "Tokyo Slim Plan 21"[2] proposed in 1997, Chiyoda, Bunkyo, and Taito Wards were to eventually have their own facilities, and if all went according to plan, the district self-sufficiency principle would have been entirely achieved by 2018. Furthermore, in the "Summary on Special Wards System Reform – Consultation Draft" (1994),[3] there were to be agreements between the

[2] The "Waste Management and Public Cleansing Act" (Haikibutsu no Syori oyobi Seisou nikansuru Houritsu) assigns responsibility for creating a waste manage-ment plan to the local governments. "Tokyo Slim Plan 21" was the waste man-agement plan proposed by the Tokyo Metropolitan Government in 1997.

[3] For a long time, each special ward was considered to be an internal organi-zation within the metropolitan government based on "the Local Autonomy Law," and compared to other municipalities (cities, towns and villages), special ward had many more limitations on their administrative functions and financial sys-tems. For this reason, in 1994, the Tokyo Metropolitan Government and the spe-cial wards proposed to the national government the "Summary on Special Wards System

Tokyo Metropolitan Government and the special wards that "each ward will autonomously conduct MSW management" after its transfer to each special ward, and the wards that did not have their own incineration plants at that point would delegate waste treatment to neighboring wards with plants, based on the premise of future plant construction in their wards. Furthermore, once rebuilding of the Edogawa incineration plant was completed, the special wards were able to incinerate all combustible waste.

From these accounts, it is clear that before transferring the waste management operation to each wards, the district self-sufficiency principle was very highly prioritized.

16.2.2 Waste Management of the Special Wards Area After the Transfer of MSW Management

16.2.2.1 Transferring the Waste Management Operation and the Regional Disposal System

In April 2000, MSW management was transferred from the Tokyo Metropolitan Government to each special ward. However, to address the dioxins issues, the incineration plants needed renovation or rebuilding. For this reason, the intermediate treatment process was to be operated by an association formed by the 23 special wards, called Clean Authority of TOKYO (hereinafter the "Clean Authority"), conducting collaborative waste treatment for a limited duration. Additionally, the Tokyo Metropolitan Government was to be take charge of the final disposal process, as this would still be landfilled in Tokyo Bay; when create and maintain landfills in Tokyo Bay, arrangements with neighboring prefectures, such as Chiba and Kanagawa, would have to be made and the Bureau of Port and Harbor of the Tokyo Metropolitan Government has this authority. Therefore, the main tasks of each ward were the collection and recycling of waste.

As noted above, the Clean Authority was set up to manage the "collaborative waste treatment for a certain period of time,"[4] and it was supposed to be dissolved in 2005. However, since existing incineration plants still had capacity and the amount of waste produced in the special wards area was declining, the need to build a plant in each ward became less urgent. Reflecting this reality, in the Metropolitan Tokyo Mayors' Council of 2003, it was stated that "there is no need to build any

Reform – Consultation Draft." The paper proposed: (a) designating each special ward as a basic local authority; (b) transferring MSW management and other local operations from the Tokyo Metropolitan Government to each special ward; (c) strengthening the local financial authority of the special wards; and (b) changes to the "Local Autonomy Law" and other laws. Based on these proposals, the "Local Autonomy Law" was reformed in 1998, and the special wards became a fundamental local authority in April 2000, when MSW management was also transferred.

[4] Quotes from the 1998, 4th Special Wards System Reform Committee's "Sugges-tions on Tokyo Metropolitan Government MSW Management Transfer."

more incineration plants at this moment," and "as for how the intermediate treatment should be handled, they stated that it should be consulted upon without being bound to the 1994 proposal." Moreover, they decided to continue collaborative treatment by the Clean Authority beyond 2005.[5] Shinjuku, Arakawa, and Nakano Wards' plan to construct incineration plants were also eliminated in the "Municipal Solid Waste Disposal Plan," formulated by the Clean Authority in the same year.

This sequence of events shows a major shift in Tokyo's waste management policy of "the district self-sufficiency principle." For this reason, the inconsistency between collaborative treatment and the district self-sufficiency principle was discussed in the Metropolitan Tokyo Mayors' Council in 2003. What emerged from this discussion was the understanding that "the district self-sufficiency principle" means each local government is fully responsible for the collection, transport, intermediate treatment and final disposal of waste; therefore, each local government must "autonomously conduct MSW management," and not necessarily that it must undertake the intermediate treatment and final disposal "within their own district completely"[5]. Other supporting reasons, such as the reduced amount of waste, financial considerations, and advance notice of the national government's 1997 "About Regional MSW Management Plan",[6] were also raised to justify continuing collaborative treatment. However, interpreting "the district self-sufficiency principle" as simply imposing managerial responsibility on each ward clearly differs from the previous policy and the general interpretation of the term. In other words, the special wards, in reality, abandoned the district self-sufficiency principle and chose to implement regional waste management instead. Nonetheless, as will be discussed later, the generated waste from the wards that have not built an incineration plant continues to be treated by their adjacent wards; thus, they have not completely abandoned the district self-sufficiency principle.

16.2.2.2 Sorted Collection and Recycling

In essence, then, though MSW management has been transferred to the special wards, intermediate treatment is handled through collaborative treatment by the Clean Authority, and the final disposal is entrusted to the Tokyo Metropolitan Government; thus, the main operation of the special wards became the processes of

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[5] Partial quote from the "Material of Metropolitan Tokyo Mayors' Council about MSW Management (Fiscal Year 2001~2005)" prepared by the Secretariat of the Metropolitan Tokyo Mayors' Council in 2006.

[6] In the notice, "About Regional MSW Management Plan," prepared by the Minis-try of Health in 1997, each prefecture was tasked with creating a regional MSW management plan with the following objectives: (a) reducing dioxins; (b) advanced processing of bottom ash; (c) promoting material recycling; (d) promoting energy recovery; (e) secure final disposal sites; and (f) reducing the cost of public works. Moreover, the requirements for payment of a national subsidy for incinerator renovation applied to the continuous combustion incinerators that could treat over 100 tons per day. However, since Tokyo's facilities (except for the is-lands) already met these requirements, the Tokyo Metropolitan Government determined that it did not need to formulate its own plan.

collection and transportation. Relatedly, the recycling of municipal waste became the responsibility of the special wards in 1992. In this section, we will examine the sorted collection and recycling processes.

The sorted collection, which started within the special wards after 1992, has been undertaken in different ways, including station collection, point collection, and group collection. To this day, the sort categories and collection system of recyclable waste differs for each ward (Table 16.1). For example, in Nakano Ward, used paper is only collected through the neighborhood group collection method, operated by the neighborhood associations, while in other wards, the local authority is responsible for the collection. Regarding plastic packaging materials (other plastics) other than PET (polyethylene terephthalate), these are not collected at all in the Bunkyo, Taito, Sumida, Ota, Shibuya, Kita, Arakawa, and Adachi Wards.

One of the reasons for such differences is the difference in each ward's financial circumstances. For example, the collection cost rises with increasing the sort categories collected by the station method. Generally, if we reduce the amount of waste through recycling, then the total cost for waste management can be reduced, thus cancelling out the increased collection cost. However, due to the constant need to renew the aging incineration plants managed by the Clean Authority, the latter's facility maintenance costs see no reduction; thus, the cost savings offered by the reduction in the amount of waste are limited. Since most of the amount paid to the Clean Authority by each ward corresponds to the amount of waste it produces, if the amount of waste is reduced, the amount the ward owes to the Clean Authority can also be reduced. However, because the Clean Authority cannot reduce the total cost, it is essentially impracticable to cancel out the increased collection cost for sorting. Therefore, reducing the amount of waste itself does is not well incentivized, causing the financially weaker wards (i.e., Arakawa, Adachi, Sumida, and Kita Wards, etc.) to avoid collecting other plastics. In addition, the special ward areas have a huge amount of business waste, which is another reason why recyclables are not aggressively sorted.

Another major change since the transfer of MSW management is that plastic, which used to be treated as non-combustible waste and disposed of in landfills, started to be treated as combustible waste and incinerated from 2008. The key reasons for this change were to extend the life of final disposal sites and to start energy recovery; however, incineration of plastics was not novel outside the special wards area. The reason for the great response to this change in the special wards area concerns the area's waste management history.

When waste collection in the special wards area restarted after World War II, kitchen waste and other trash (miscellaneous trash) were collected separately, with part of the kitchen waste used as pig feed and for compost materials, and the rest sent to landfill. Miscellaneous trash mostly comprised flammable materials, such as paper and fabric, and was, therefore, incinerated. With the economic growth that soon ensued, pig farms and other farmland within the special wards area started to diminish. This led to issues of methane gas and flies at the final disposal sites; therefore, in 1961, it was decided that kitchen waste would be collected and incinerated with miscellaneous trash. However, as kitchen waste is very moist and low in caloric values, issues concerning incomplete combustion often arose. The incineration facilities built in the area from the 1960s to the

Table 16.1 Sorting and collection of recyclable waste in the special wards of Tokyo, 2010

	Cans	Glass bottles	PET bottles	Used papers	Other plastics	Drink cartons	Food trays	Other papers	Used clothes	Food oil	Dry cells	FLs
Chiyoda	SPG	SP	SP	SPG	S	SPG	SP	G	P	P	P	–
Chuo	SG	SG	SPG	SG	S	PG	P	G	P	P	P	P
Minato	SG	SG	SPG	SG	S	PG	P	G	–	G	P	–
Shinjuku	SG	SG	SP	SG	S	PG	P	G	–	–	P	–
Bunkyo	SG	SG	SPG	SG	–	PG	P	G	P	–	P	–
Taito	SPG	SG	SP	SG	–	SPG	S	G	P	P	P	P
Sumida	SG	SG	SP	SG	–	SG	S	–	–	P	P	–
Koto	SG	SG	SP	SG	S	G	S	G	–	P	P	–
Shinagawa	SG	SG	SPG	SG	S	G	–	G	S	S	S	S
Meguro	S	S	SP	SG	S	PG	–	G	–	–	P	–
Ota	SG	SG	SP	SG	–	SG	S	–	–	P	–	–
Setagaya	SG	SG	SPG	SG	P	PG	P	G	–	P	–	–
Shibuya	SG	SG	SP	SG	–	PG	P	G	P	P	–	–
Nakano	SG	SG	SP	G	S	PG	–	–	P	–	P	–
Suginami	SG	SG	SB	SG	S	SG	–	G	P	–	–	–
Toshima	SG	SG	SP	SG	S	S	S	G	S	P	P	–
Kita	SG	SG	SP	SG	–	PG	P	G	P	P	P	–
Arakawa	SG	SG	SPG	SG	–	G	SPG	–	–	–	–	–
Itabashi	SG	SG	SP	SG	P	PG	P	–	–	–	P	–
Nerima	SG	SG	SP	SG	S	PG	–	G	P	P	P	–
Adachi	SG	SG	SP	SG	–	SG	P	–	–	–	–	–
Katsushika	SG	SG	SPG	SG	S	SPG	SP	G	P	–	P	P
Edogawa	SG	SG	SPG	SG	S	SG	–	G	–	–	–	–

Source: Data from Clean Association of TOKYO23 (Kurishima 2014)
S station collection (collection at stations), *P* point collection, *G* group collection, *FLs* fluorescent lamps

1970s area were low-calorie incinerators.[7] Subsequently, in the 1970s, plastic waste rapidly increased. As plastics have high caloric value, they could damage low-calorie incinerators; moreover, some plastics release harmful gases, such as hydrogen chloride, when incinerated. However, the incineration plants of the time were not equipped or set up to handle such challenges. Additionally, as noted earlier, incineration plants were not ready to handle the rapidly increasing amount of MSW, leading to significant amounts of kitchen wastes being transported directly to landfill. For this reason, the special wards area designated plastics as non-combustible waste and decided to send them directly to landfill in 1960s In the 1990s, the updated or newly built incinerators were equipped to handle high-calorie waste and had set up ways to handle gas emissions. These changes finally enabled all combustible waste to be incinerated. These incineration plants were also now equipped with boilers or power generators that utilized the heat waste. With such energy recovery systems in place, plastics finally (after 30 years) came to be treated as combustible waste and sent to the incinerators. This marks a big shift that is, perhaps, unique to the special wards area of Tokyo, which experienced urbanization faster than anywhere else in Japan, and began to engage in waste management from early on.

However, energy-recovery incineration that treats plastics as combustible waste clearly differs from the policy, chosen by some wards, of sorting plastics as recyclable materials. Therefore, the sorting rules of plastic waste differ between wards.[8] The fact that the responsible authorities differ for each waste disposal process is the cause of this policy mismatch.

16.2.3 Future Prospects

16.2.3.1 Waste Collection

As noted earlier, after the transfer of MSW management to the special wards, their main function in this management process became the collection, transportation, and recycling of waste. In other words, these are the domains in which characteristics vary by ward. In some wards in recent years, combustible and non-combustible waste have been collected door-to-door. At the time of writing (April, 2017), Shinagawa Ward has completely implemented door-to-door collection, and Minato, Taito, Sumida, Koto, Nakano, Toshima, Kita, and Nerima Wards partially implement this practice. Other wards collect at stations (see Table 16.2 for details of the different approaches in each ward). Generally, the reasons given for implementing door-to-door collection methods are to improve residential services or to clarify who is responsible for any

[7] Most of the incinerators built around the 1960s to the 1970s were designed to prevent the incomplete combustion of low calorie waste, such as kitchen waste. These incinerators were designed to withstand a heating value of up to about 2000 kcal.

[8] In the wards that do not sort other plastics, the designation was changed from non-combustible to combustible waste. However, in the wards that do sort them, while stating that they are basically promoting sorting, they complicate matters by also stating that, depending on the condition of the plastic waste (as regards filth, etc.), it will be incinerated as combustible waste for energy recovery.

Table 16.2 Collection method of combustible and non-combustible waste in the special wards of Tokyo, 2009

	Collection system	Frequency	
		Combustible (/week)	Non-combustible (/month)
Chiyoda	Combined	2	5
Chuo	Collection at station	2	4
Minato	Collection at station	2	2
Shinjuku	Combined	2	4
Bunkyo	Collection at station	2	4
Taito	Combined	2	2
Sumida	Collection at station	2	2
Koto	Collection at station	2	2
Shinagawa	Door to door collection	2	4
Meguro	Collection at station	2	2
Ota	Collection at station	2	2
Setagaya	Collection at station	2	2
Shibuya	Combined	2	2
Nakano	Collection at station	2	2
Suginami	Collection at station	2	2
Toshima	Combined	2	2
Kita	Combined	2	2
Arakawa	Collection at station	2	2
Itabashi	Combined	3	2
Nerima	Collection at station	2	2
Adachi	Collection at station	3	2
Katsushika	Combined	2	2
Edogawa	Collection at station	2	2

Source: Data from the Ministry of the Environment, Japan (Kurishima 2014)

given type of waste. In reality, the reason behind some special wards implementing a door-to-door service is the increasing difficulty of securing space for a waste station. Typically, one waste station is shared among residents, ranging from a few households to a dozen or more, and the location of each station is decided based on consultation between neighborhood associations and the residents themselves. However, as people are becoming less familiar with their neighbors, a growing number are refusing to accept having a waste station in front of their home where strangers will deposit their garbage. While door-to-door collection does increase the collection cost, as society ages further and people associate less with their neighbors, it is likely that this method will become more common in Japan's larger cities.

16.2.3.2 Intermediate Treatment

With the policy shift away from the district self-sufficiency principle in 2003, the special wards stopped building new incineration plants in the wards that did not already have them, focusing instead on updating and maintaining the existing plants and treating waste collaboratively. Nonetheless, "the equitable sharing of nuisance" that was the core rationale for behind the district self-sufficiency principle remains a central tenet.

The idea of "regional balance" is an example of such tenet. The amount of waste generated in the special wards area has decreased and their capacity to incinerate exceeds the demand. In this situation, when considering the efficiency of incineration or the use of its heat, along with the environmental load, it is arguable that some plants should be shut down and the remaining incinerators should be more consolidated. However, the use of incineration plants in the special wards is not consolidated; instead, plants have to adjust their capacity accordingly (including reducing the incinerator capacity). In renovating plants, the priority is to avoid a concentration of inoperable plants in any given area concurrently. Considering the "regional balance" when planning of facility maintenance is based on the agreed policy that regions or districts without a facility should have their waste handled in their neighboring ward; thus, this can be perceived as part of sharing equal responsibility (Fig. 16.3).

Another aspect of this tenet is the shared cost of the Clean Authority. Originally, this was based on the population of each ward. However, as the special wards area has more business waste, the amount of waste generated does not correspond proportionally to the size of the population. Following discussions in the Metropolitan Tokyo Mayors' Council, it was decided that from fiscal year 2006, the shared cost would be calculated based on the amount of waste in each ward. Subsequently, in 2008, it was decided that there should also be a financial adjustment to reflect fairer

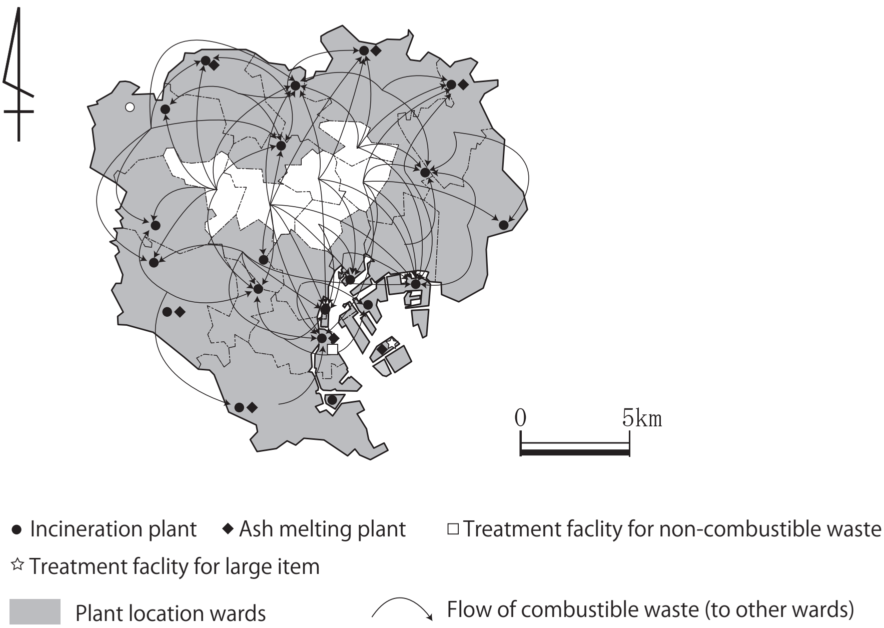


Fig. 16.3 Location of MSW treatment facilities and waste flow in the special wards of Tokyo, 2010 (Source: Data from Clean Association of TOKYO23 (Kurishima 2014))

sharing of the burden of the plants' location, and this has been implemented since 2010. This means that while the wards that send their waste to other wards (i.e., the wards without incinerators) are charged more based on how much waste they send, the wards with incinerators that take in more than a certain amount of waste pay less. This was a means to internally adjust for the external cost of having an incineration plant on their land.

Thus, while the district self-sufficiency principle has been abandoned in all practical measures, it is likely that sharing and balancing the burden among wards, the aim from the start of the "Garbage War," will likely remain a basic policy of MSW management in the special wards area.

16.2.3.3 Final Disposal

Currently, final disposal for the special wards area is effected at Tokyo Bay's Central Breakwater Outer Landfill Site and the New Sea Surface Disposal Site. As noted earlier, at the Clean Authority's request, final disposal is handled by the Tokyo Metropolitan Government, which also manages the final disposal site. After peaking in 1989, the amount of disposal waste has since been reduced, especially after bottom ash melting began in 1991,[9] followed by the incineration of all combustible waste since 1997, and then plastics incineration starting in 2008. Based on these developments, it is estimated that the disposal site has more than 50 years of remaining landfill capacity, which is more than that in other Japanese metropolises.

16.3 Waste Management in the Tama Area

16.3.1 Urbanization and the Waste Problem

16.3.1.1 Urbanization and the Establishment of the Waste Management System

From the 1960s, with the rapid urbanization, the amount of MSW in the Tama area significantly increased. However, this increase was not simply due to an increase in population or the number of households. One reason for the increase was that, against the backdrop of rapid economic growth, the mass consumption lifestyle spread to the suburbs, with the many new residents moving into the new housing

[9] Melting the bottom ash at over 1200 °C causes the dioxins within the ash to de-compose. This process also locks in heavy metals and reduces the ash's volume by 50%. The slag thereby created can be used for construction. The melting of bottom ash in the special wards area started at Ota No.2 Plant in 1991. In 2013, there were six incineration facilities with the capability to conduct ash melting in the special wards area, one of which was in the Central Breakwater area. Howev-er, four ash melting facilities have been shut down, leaving two facilities by 2016, for a variety of reasons, such as the demand for slag, CO2 emissions, the associated costs, etc.

areas. In addition, with diminishing pig farms and farmland, usage of the feed and compost materials made from kitchen waste reduced, and with an increase in population density, burning garbage at home became impractical. The population increase and the change in the industrial structure and land use engendered by urbanization reduced the amount of waste self-disposal; consequently, the need for waste management by the public sector increased. In the Tama area, urbanization and the enactment of the Public Cleaning Act (*Seisou Hou*)[10] led to the establishment of waste management by municipalities from the 1950s to the 1960s.

Many of the Tama area's municipalities implemented a collection method using neighborhood waste containers (called "dust box").[11] There are four reasons why this collection method was introduced at that time. First, the covered dust box was excellent not only aesthetically but also for promoting public health. Second, this was a convenient method for the residents, as they could dispose of their waste at any time. From the processors' perspective, it was more efficient than door-to-door collection, and since they used cranes for collection, it was physically easier on the collection workers. By 1990, ten municipalities in the Tama area had implemented the neighborhood dust box collection method. At that time, the main problem of waste management was how to realize the appropriate treatment of the discharged waste; the dust box method of waste-collection was a coherent solution.

Intermediate waste processing was mainly by incineration, and as of 1972, there were 21 incineration plants in operation, 15 of which were operated by municipalities, and six by joint administrative organizations. The Tama area was able to incinerate all combustible waste by 1978, much sooner than the special wards area. By 2000, of the 30 municipalities in the Tama area, 24 organized the eight joint administrative organizations, collaboratively treating combustible waste (Kurishima 2004). Many collaborative treatments were adopted due to the difficulty of securing land for construction, much like the special wards, in addition to the financial pressure to improve the social infrastructure and other public services to handle rapid urbanization.

The remaining question for the Tama area, which had the ability to incinerate all combustible waste, was how to secure final disposal sites. Until the 1950s, they had less MSW to dispose of, and, thus, adopted the simple method of burying the waste in nearby pits; however, as soon as MSW started to increase in the 1960s, they were unable to dispose of the waste. Many municipalities had consigned final disposal to private companies, and this became a problem as some companies were found to be

[10] The Public Cleaning Law was passed in 1954, when waste was starting to become an issue in Japan's metropolis areas. In this law, the special wards and all city were designated as "special cleaning areas" and each local government had to collect and dispose of waste within its designated areas. In the special cleaning areas, it was illegal to collect or dispose of waste as a business without permission; therefore, wastes were collected by the local government directly in the metropolitan areas. It was also allowable for the prefecture governors to designate any town or village in part or in whole as a "special cleaning areas."

[11] They were collected by a crane mounted on the collection vehicles. The crane moved each container above the loading bed of the collection vehicle, at which point the bottom of the container opened to dump the contents into the vehicle.

dumping the waste in inappropriate ways. At that time, there were many pits left by gravel gathering in Hamura Town and Mizuho Town, which had a good quality gravel layer. The companies entrusted with final disposal of the waste dumped municipal waste and industrial wastes into these gravel pits indiscriminately and without treating kitchen waste. This caused several pollution-related problems around the pits, such as terrible odor, the mass generation of flies, and groundwater contamination. Therefore, in 1976, Hamura Town and Mizuho Town pursued legal action against these companies and 19 municipalities in the Tokyo District Court, seeking the prohibition of waste dumping in the gravel pits; reconciliation of the two sides resulted in suspension of the dumping.[12] However, many of the Tama area's municipalities were unable to secure final disposal sites on their own; eventually, 27 municipalities formed the Regional Waste Disposal Association of Tokyo Santama Region (hereinafter the "Santama Disposal Association")[13] in 1980, and the landfilling of waste in the Yatozawa final disposal site in Hinode Town began in 1984. This was how the region's current final disposal system was established.

16.3.1.2 Escalation of the Waste Problem

Tama area's waste management system was established in response to urbanization from the 1960s to the 1970s, but the waste problems further worsened.

The biggest issue concerned lack of capacity at the final disposal sites. The amount of MSW further increased during Japan's bubble economy years, and the capacity of the Yatozawa final disposal site was ultimately exhausted. The site was also suspected of possible leakage of polluted water, due to a break in the seepage control sheet,[14] which ignited residents' loss of trust in the disposal site and in the Santama Disposal Association. Against the background of this breach of trust, a large social conflict arose when the Santama Disposal Association severely clashed with those opposing the construction and use of the Futatsuzuka final disposal site, planned to replace the Yatozawa site. In October 2000, the Tokyo Metropolitan Government executed the eminent domain to secure the land for the Futatsuzuka

[12] Conversely, with a three-year limit from 1980, Hino and other cities brought their wastes to the Hamura final disposal site operated by the Tokyo Waste Disposal Site Management Association (Tokyo Toshi Haikibutsu Shobunchi Kanri Kumiai). With time running out in 1982, Hino City proposed to stop the usage of dust boxes; however, at this time, the residents rejected the plan and the proposal was withdrawn.

[13] With the completion of the eco-cement facility (see note 15), administrative work was no longer limited to final disposal. Therefore, in April 2006, the collaboration changed its name to "Tokyo Tama Regional Association for Waste Management and Resource Recycling," which remains in use today.

[14] The hydrophobic or impermeable sheet or wall installed beneath and around the sides of the landfill, to prevent contaminated water from leaking out, is called a seepage control work. The landfill sites where municipal waste, including household waste, is disposed of are obligated to install seepage control work and water treatment facilities on-site. At the Yatozawa final disposal site, a break in the seepage control rubber sheet was suspected.

final disposal site on behalf of the Santama Disposal Association. This affair has incurably scarred the relationship between the administration and the residents, and it became extremely difficult to secure the next site after the Futatsuzuka disposal site within the Tama area. Due to this situation, in 1992, with the purpose of extending the useful life of the final disposal site, the Santama Disposal Association set a quota landfilling amount of waste for the participating municipalities. When the municipalities exceeded their allocated limit, they were billed in addition to the association fees. The quota amount has been decreased each year, serving to incentivize the municipalities to significantly reduce the amount of MSW.

16.3.2 The Great Change of MSW Management in the Tama Area: A Case Study on Hino City

16.3.2.1 The Change of MSW Management in Hino City

With the quota landfilling amount of waste set by the Santama Disposal Association, the Tama area's municipalities were forced to shift their focus from how to realize the appropriate treatment of discharged waste to how to reduce the amount of final disposal waste. In this section, we examine Hino City's system change in October 2000 as a case study to show how MSW management in the Tama area transformed.

First, they began to charge for the collection and disposal of waste. The fees vary by the amount of waste: 20 yen per 10-liter bag, 40 yen per 20-liter bag, and 80 yen per 40-liter bag (and, from 2001, they offered a 10 yen per 5-liter bag). This price is among the highest in Japan. More specifically, only combustible and non-combustible wastes were charged, while recyclable waste remained free of charge. The purpose was to promote the separating of recyclable waste and to reduce disposal waste. As Table 16.3 shows, the move to charge for waste disposal became widespread in the Tama area, and though there are differences in the amount charged, by 2010, 21 municipalities were charging fees. For further consideration, Yamatani (2007) offers detailed insight into the history of charging fees for waste in the Tama area.

Second, they abolished the use of dust boxes. In April 2000, there were 2519 dust box sites for combustible waste and 2465 for non-combustible waste in Hino City. The city removed all of these dust boxes. While covered dust boxes had the advantage for the residents of being able to dispose of their waste at any time, their downside was increasing the amount of waste, as covered dust boxes impede the drive to properly sorted waste. Therefore, abolishing the dust boxes was promoted to resolve these problems. This movement became widespread in the whole of the Tama area, and when Fuchu City abolished its use of dust boxes in February 2010, dust boxes disappeared from the Tama area entirely.

Third, they implemented the door-to-door collection method. To that point, they had used the neighborhood dust boxes to collect combustible and non-combustible

Table 16.3 Collection stage of MSW in the Tama region, 2010

	Charged			Frequency	
	Levy system	Start from	Collection system	Combustible (/week)	Non-combustible (/month)
Hachioji	Quantity of waste	Oct. 2004	Door to door	2	4
Tachikawa	Free		Collection at station	2	4
Musashino	Quantity of waste	Oct. 2004	Door to door	2	2
Mitaka	Quantity of waste	Oct. 2009	Door to door	2	2
Oume	Quantity of waste	Oct. 1998	Door to door	2	1
Fuchu	Quantity of waste	Feb. 2010	Door to door	2	2
Akishima	Quantity of waste	Apr. 2002	Combined	2	1
Cyofu	Quantity of waste	Apr. 2004	Door to door	2	2
Machida	Quantity of waste	Oct. 2005	Combined	2	2
Koganei	Quantity of waste	Aug. 2005	Door to door	2	2
Kodaira	Free		Collection at station	2	4
Hino	Quantity of waste	Oct. 2000	Door to door	2	4
Higashimurayama	Quantity of waste	Oct. 2002	Door to door	2	1
Kokubunji	Free		Door to door	2	4
Kunitachi	Free		Collection at station	2	4
Fussa	Quantity of waste	Apr. 2002	Door to door	3	1
Komae	Quantity of waste	Oct. 2005	Door to door	2	2
Higashiyamato	Free		Collection at station	2	1
Kiyose	Quantity of waste	June 2001	Collection at station	2	2
Higashikurume	Free		Combined	2	4
Musashimurayama	Free		Collection at station	2	1
Tama	Quantity of waste	Apr. 2008	Combined	2	2

(continued)

Table 16.3 (continued)

	Charged		Collection system	Frequency	
	Levy system	Start from		Combustible (/week)	Non-combustible (/month)
Inagi	Quantity of waste	Oct. 2004	Door to door	2	2
Hamura	Quantity of waste	Oct. 2002	Door to door	2	1
Akiruno	Quantity of waste	Apr. 2004	Door to door	2	4
Nishitokyo	Quantity of waste	Oct. 2010	Door to door	1	2
Mizuho	Quantity of waste	Oct. 2004	Door to door	2	2
Hinode	Free		Collection at station	3	4
Hinohara	Free		Collection at station	2	2
Okutama	Number of men	July 1955	Collection at station	2	2

Source: Data from the Institute for Tokyo Municipal Research (Kurishima 2014)

waste, while a designated collection station had been used for recyclable waste. The city switched collection of all waste to the door-to-door method, intended to clarify the identity of each waste generator and to promote reduction in waste, as well as encourage separating. In the Tama area, as of 2010, 17 municipalities were collecting combustible waste door-to-door, and four cities have partially implemented this method (Table 16.3).

Fourth, they changed the collection frequency. For combustible waste, collections were reduced from three times to twice per week, and non-combustible waste collection was reduced from twice to just once per week. The aim was mainly to reduce the amount of waste. As of 2010, combustible waste is collected twice weekly in 27 municipalities. The exceptions are Fussa City and the town of Hinode, which collect three times per week, and Nishitokyo City, with only one collection per week (Table 16.3).

16.3.2.2 The Results of the Changed MSW Management System

Figure 16.4 shows the changes in the amount of MSW and its breakdown in Hino City. Before the change, in 1999, the total waste generated in the city was 65,559 tons; in 2001, after the change, it was reduced to 54,074 tons. Ten years after the change, in 2010, the total amount of MSW was reduced to 46,919 tons. Meanwhile, the disposal waste in 1999 was 58,998 tons, which was reduced to 38,941 tons in 2001, reduced further to 34,929 tons in 2010. Evidently, the reduction of disposal waste is

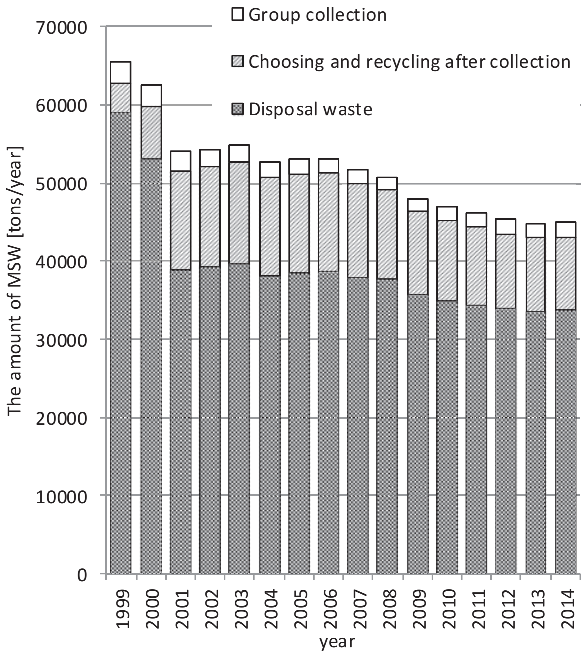


Fig. 16.4 Changes in the amount of MSW and its breakdown in Hino City, 1999–2014 (Source: Data from the Institute for Tokyo Municipal Research. Modified from Kurishima (2014))

much more significant than the total waste reduction. Therefore, the effect of this change was less in the reduction of the amount of waste and more in the improvement of recyclables sorting by the residents.

The composition of combustible waste and non-combustible waste also demonstrates a reduction in the mixing of the recyclable waste and disposal waste. In 1999, before the change in Hino City, paper comprised 44.1% of all combustible waste; however, in 2002, that was reduced to 30.6%, and by 2010, it was further reduced to 27.2%. Non-combustible waste also expressed the same trend: in 1999 metals comprised 25.8% of the non-combustible waste, and glass was 20.8%; by 2002, metals had reduced to 14.8% and glass to 6.3%, with further reductions in 2009, as metals comprised just 10.9% and glass 3.1%. Paper, cans, and glass bottles, which had previously been disposed of as disposal waste, started to be clearly sorted as recyclable waste.

Due to these changes, the amount of waste being deposited into the final disposal site diminished from 7347 m^3 in 1999 to 4373 m^3 in 2001, which was less than the quota amount set for Hino City by the Santama Disposal Association.

Tama area, as a whole, has also produced less total waste, including disposal waste, since 2004 (Fig. 16.5). In fiscal year 2004, Hachioji City, Musashino City, Chofu City, Inagi City, Akiruno City, and Mizuho Town implemented waste system charges, bringing the total number of Tama area municipalities charging for waste to 14. Most of these municipalities also stopped using neighborhood dust boxes, switching to the door-to-door collection method. The final disposal amount has also

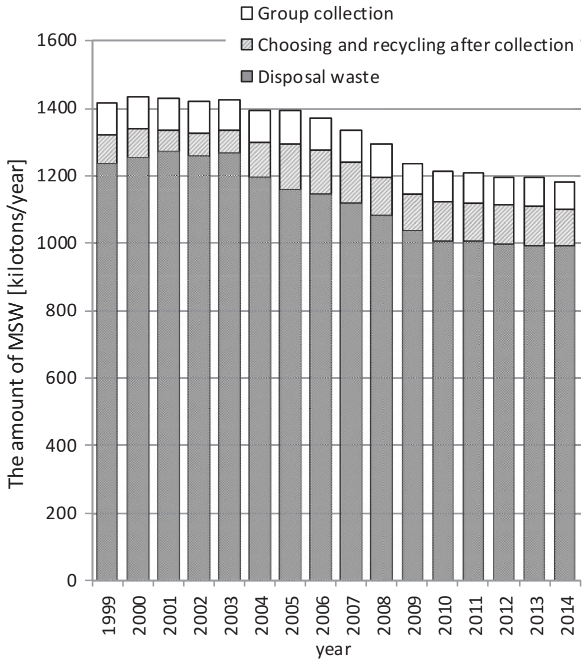


Fig. 16.5 Changes in the amount of MSW and its breakdown in the Tama region, 1999–2014 (Source: Data from the Ministry of the Environment, Japan (2014) Modified from Kurishima (2014))

has shown a declining trend ever since the quota amounts for each municipality were set by the Santama Disposal Association. Furthermore, with a new eco-cement[15] plant, which uses bottom ash as the cement's main raw material, becoming operational in July 2006, that final disposal amount was reduced even more (Fig. 16.6).

16.3.2.3 Changes in Sorting Behavior

As noted earlier, one of the main reasons for the change in the amount of disposal waste in Tama area was the improvement in sorting recyclable waste. This section provides a close examination of the behavioral changes in disposing of recyclable waste, based on surveys of residents in three districts of Hino City.[16]

[15] Eco-cement is a cement that uses incinerated ash as its main ingredient. Dioxins and other organic chemical compounds are broken down in a firing kiln heated to over 1350 °C and become harmless, thus ensuring safety in the cement's use. The bottom ash historically dumped into landfills can be recycled; thus, it is considered a good option for resolving the ever-decreasing capacity of the final disposal sites. Eco-cement became standardized in 2002 through JIS (Japanese Industrial Standard).

[16] The questionnaire survey was conducted between May and June 2002. Valid responses numbered 368 and the response rate was 36.8%. The returned responses by district were: 31.0% for Hino-Honcyo 4th district, 52.0% for Mima-ni-Mogusa, and 29.3% for Mogusadai.

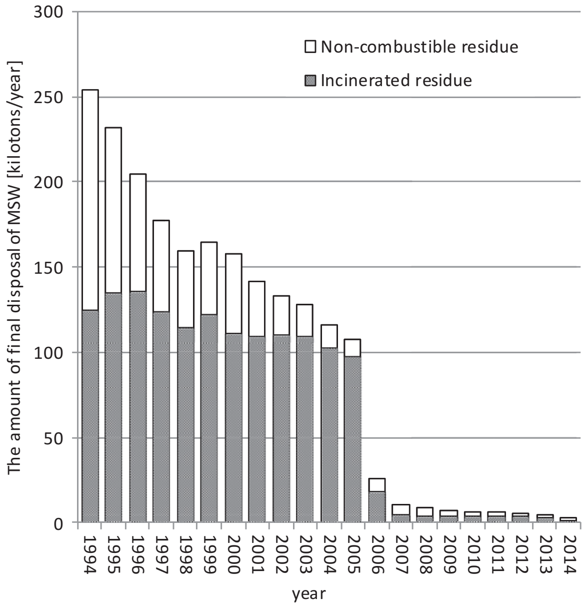


Fig. 16.6 Changes in the amount of final disposal of MSW in the Tama region, 1999–2014 (Source: Data from the Institute for Tokyo Municipal Research. Modified from Kurishima (2014))

The three districts selected for the case study are Hino-Honcho 4th district, Minami-Mogusa district, and Mogusadai district. Hino-Honcho 4th district is located northeast of Hino Station on the East Japan Railway Company (JR East) Chuo Main Line, and its southernmost part is crossed by National Route 20 (at the time of the survey). This district was the center of the old Hino Town, and many fragmented housing lots have developed in this district, due to the high accessibility of both Hino Station and National Route 20. At present, we can observe the mixture of detached houses and low-rise apartment houses. As there was no district readjustment plan, the district structure remains very complex with many narrow roads and one-way streets. Minami-Mogusa district is a housing estate with detached houses, developed by Nippon Shinpan Co., Ltd. on the Nanao hill in the 1970s. There were 650 households when the site was first developed. Mogusadai district, which is adjacent to the west side of Minami-Mogusa district, is a medium-rise collective housing estate, developed from 1969 to 1970 by the Japan Housing Corporation (now the Urban Renaissance Agency). Both districts show orderly city blocks and relatively wide streets.

As noted above, before the MSW management system changed in Hino City, combustible and non-combustible waste were dropped off in neighborhood dust boxes, and recyclable waste was collected in designated recyclable waste collection stations; there were 2519 dust boxes for combustible waste and 2465 dust boxes for non-combustible waste. However, there were only 412 collection stations for recyclable waste, causing many citizens to have to travel much further to dispose of their recyclable waste. These collection stations were set in public squares or parks where larger plots of land were available, as the system required various baskets or containers to separately collect different categories of recyclable items. In addition, these locations had to be in places accessible to collection vehicles out. Therefore, the proximity to citizens of any one of the recyclable materials collection stations depended largely on the district's layout.

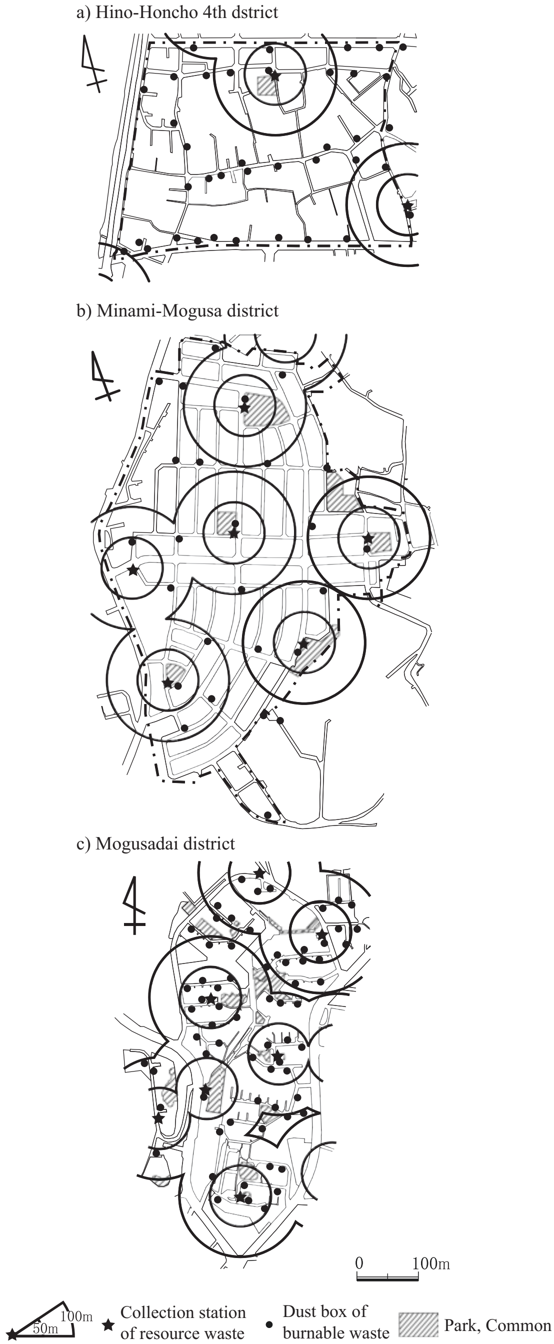
Figure 16.7 shows maps of the recyclable waste collection stations and the locations of combustible waste dust boxes in all three of the study districts before the collection system changed. Hino-honcho 4th district had very few public squares or parks that could accommodate recyclable waste collection stations, and as the roads were narrow, there were limitations on which locations were accessible to collection vehicles. For these reasons, there were only two collection stations, located near another district on the north side, with limited accessibility for residents. Conversely, Mimani-mogusa and Mogusadai districts had many open areas and parks, which had been integrated at the time of their respective housing developments. Additionally, with wider roads, there were several collection stations throughout the district. In other words, collection stations had good accessibility for residents.

Based on these location of collection stations, Fig. 16.8 shows the destinations of recyclables waste in the study districts. First, we will examine the destination of recyclables waste before the change in waste management system. For example, in Hino-honcho 4th district, 60.2% of the cans were being disposed of via dust boxes, and only 26.9% were collected for resource recycling; 26.3% of cans in Mimani-mogusa district were disposed of via the dust boxes, while 54.1% were successfully sorted into recycling; in Mogusadai district, the percentages of cans disposed via dust boxes and sorted for recycling collection were approximately the same. These differences were most likely due to the different accessibility of these collection stations. A clear example can be seen Mimani-mogusa district, where there was a high rate of collection of recycled waste. The further away the residents were from a recyclable waste collection station, the less they deposited their recyclables at these stations. Instead, more of these people opted to dispose of their recyclables through the neighborhood group collection activities (Fig. 16.9).

All this transformed with the change in the MSW management system, with the recycling collection rates in Hino-Honcho 4th district, Minami-Mogusa district, and Mogusadai district increasing to 93.5%, 80.0%, and 83.3%, respectively. On the other hand, there was less disposal as non-combustible waste (Fig. 16.8). It is also worth noting that, unlike before the change, hardly any differences were seen in the behavior of each of these districts' residents.

When the root causes of such changes are examined, the first was evidently the introduction of charging for waste, which led to more rigorous waste sorting. Since charges were applied to collection of combustible and non-combustible waste while recyclable waste was collected for free, people started to dispose of recyclables as recyclable waste. That said, some argue that charging for waste will lead to waste reduction only temporarily as, over time, people will revert to their previous behavior (Taguchi 2005; Yamatani 2007, etc.). The other reason for Hino City and the Tama area's continuing success, managing to achieve comprehensive waste sorting and a reduction in the waste requiring processing, is the implementation of door-to-door collection. By providing door-to-door collection of recyclable wastes along-

Fig. 16.7 Location of the collection stations of recyclable waste and dust boxes in the study districts, 1999 (Source: Data from Hino City (Kurishima 2014))



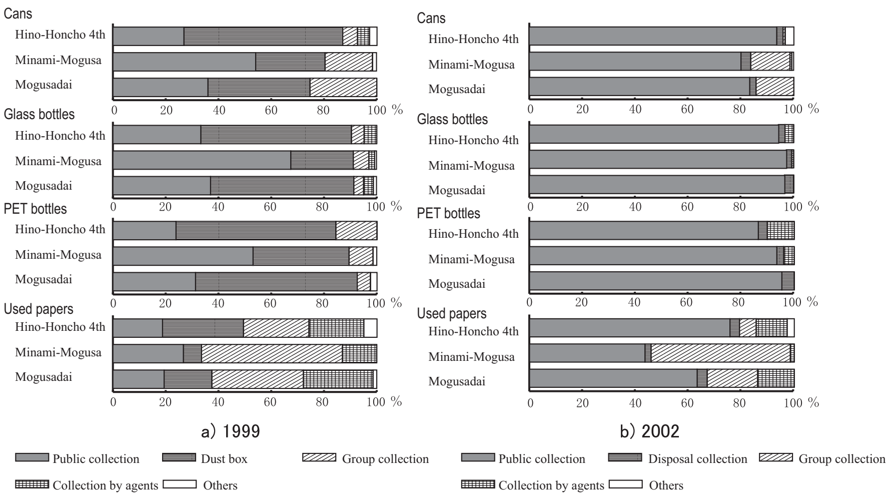


Fig. 16.8 Changes in discard destinations of recyclable waste in the study districts, 1999 to 2002 (Source: Questionnaire survey (The questionnaire survey was conducted between May and June 2002. Valid responses numbered 368 and the response rate was 36.8%. The returned responses by district were: 31.0% for Hino-Honcyo 4th district, 52.0% for Mima-ni-Mogusa, and 29.3% for Mogusadai). (Kurishima 2014))

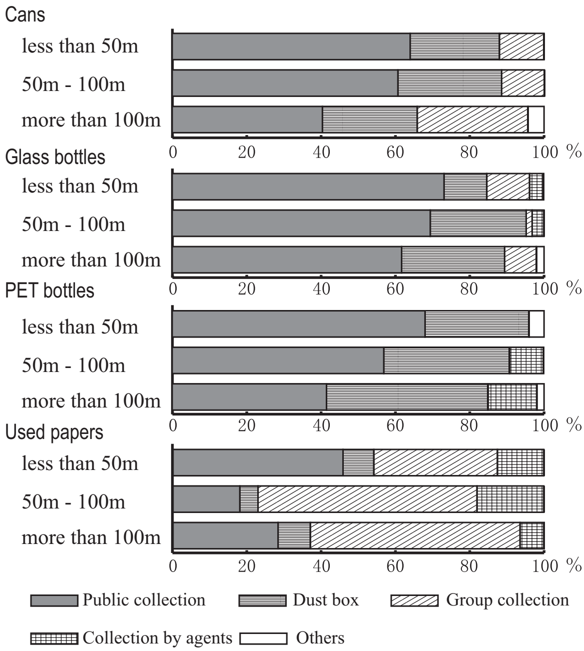


Fig. 16.9 Discard destinations of recyclable waste and distance from each station in the Minami-Mogusa District, 1999 (Source: Questionnaire survey (The questionnaire survey was conducted between May and June 2002. Valid responses numbered 368 and the response rate was 36.8%. The returned responses by district were: 31.0% for Hino-Honcyo 4th district, 52.0% for Mima-ni-Mogusa, and 29.3% for Mogusadai) (Kurishima 2014))

side combustible and non-combustible wastes, the new system not only clearly identified what each household was disposing of but also resolved the problem of distance to the collection stations, which previously led to recyclables being mixed with other disposal waste. Such changes were most likely the cause of the observed behavioral change.

16.3.3 Future Prospects

16.3.3.1 Waste Collection

Hino City and the Tama area have switched their policy to reducing disposal waste, and have been successful in this regard. By combining a door-to-door collection service with charging for waste, the Tama area achieved the accolade of least waste disposed-of per capita in Japan. Conversely, by implementing the door-to-door collection method, the collection cost increased and collection efficiency decreased. These municipalities are not financially robust, though they have more leeway as regards final disposable landfill site capacity after implementing the processing of bottom ash into eco-cement. Therefore, it is difficult to immediately conclude whether the current collection system to reduce waste, which places a great burden on the municipalities, will be continued.

Additionally, though it was not possible to provide an in-depth analysis here, we can assume that by implementing door-to-door collection methods and by enhancing the resource collection by municipalities, the relationships that were often fostered among neighbors (though the collective efforts of sorting or the group collection of recyclable waste) are somewhat weakened. When the station collection method was used, responsibility for maintaining the station was shared among the neighbors by rotating the person in charge. Moreover, those who came to dispose of their waste also had a chance to meet their neighbors. In short, these traditional ways of handling waste in these areas were a way to establish relationships between neighbors. Additionally, as can be seen in Fig. 16.4, the more direct involvement of municipalities in collecting recyclables reduced the number of group collection activities, which were, in fact, the funding source of local residents' organizations, such as neighborhood associations and children's associations.

16.3.3.2 Intermediate Treatment

Intermediate treatment, which includes incineration though collaborative management, was established in the Tama area from the 1960s to the 1970s, and remains the same today. During this time, there were upgrades to the facilities, but some were unable to revamp their facilities and had to dissolve their association. For example, the Nimaibashi Sanitation Association, composed of Fuchu City, Chofu City, and Koganei City, was unable to build a new incineration plant. Consequently, the

Koganei City administration fell into confusion over how to handle MSW management.[17] Typically, such waste management facilities tend to face the NIMBY[18] response, and the neighboring residents protest the construction of such facilities. In the Tama area, which has now been fully urbanized, there is a possibility that the same situation will recur in the future.

16.3.3.3 Final Disposal

For many years, the Tama area's waste management was affected by the issue of final disposal sites. When the Futatsuzuka disposal site became the last final disposal site in the Tama Area in 1992, the Santama Disposal Association had to implement a quota landfilling amount of waste for each municipality, which, in turn, caused a major shift in the Tama area's MSW management system.

However, the situation has changed since the eco-cement plant, which uses bottom ash, became operational in July 2006 within the Futatsuzuka disposal site. When the plant's operations began, the disposal site became a landfill for non-combustible residue only. In 2000, the final disposal amount in the Tama area was 151,464 tons; after the plant started operating, the final amount in 2006 was down to just 25,684 tons, which dropped even further to 6159 tons in 2010, contributing to the extension of the final disposal site's useful life (see Fig. 16.6). Within the reduced final disposal amount, the reduction of non-combustible residue was due to better sorting of recyclable waste consequent to the MSW management system change, whereas the major reduction in bottom ash was the effect of the eco-cement plant. However, because eco-cement needs the chlorine contained in the incineration ash to be pre-treated, and as the plant is small, the production cost is higher compared to ordinary portland cement. Therefore, at the time of writing, all the produced eco-cement has been used in public projects; in order to maintain this waste management approach, it will be necessary to continually find new users and uses.

[17] The Nimaibashi Sanitation Association's incineration plant (operational from 1957) was shut down in March 2007 due to the aging of the facility. Prior to its closure, there were various proposals on building a new (replacement) incineration plant. However, the proposals were aborted in the face of strong opposition from neighboring residents. With the plant's closure, Fuchu City began collaborative treatment with the Tamagawa Sanitation Union, and Chofu City began collaborative treatment with Mitaka City. Concurrently, Koganei City exchanged a memorandum about collaborative treatment with Kokubunji City, but they were unable to find land to build their incineration plant. Therefore, after the Nimaibashi incineration plant was shut down, Koganei City had to request waste treatment support from nearby municipalities as an emergency measure. However, the new mayor, elected in April 2011, insisted on shifting from incineration treatment, stating that the commission cost was wasteful. The neighboring municipalities accepting Koganei's waste objected strongly to his remarks, thereafter adopting an uncooperative attitude toward accepting the city's waste. Consequently, Koganei City's waste threatened to become unmanageable; therefore, the mayor decided to resign his position.

[18] An acronym for the phrase "Not in My Back Yard." While everyone agrees with the need for such facilities, nobody want to accept them in their neighborhood.

16.4 Conclusion

This chapter examined the actual conditions for managing MSW after the period of rapid economic growth and its future prospects, dividing Tokyo into the special wards area and the Tama area.

In the special wards area, the Tokyo Metropolitan Government constructed waste incineration plants based on the district self-sufficiency principle (disposing of your own waste in your own ward), which were established following the “Garbage War” in the 1970s. However, MSW management in the Tokyo special wards area changed greatly after responsibility for MSW shifted to the special wards in 2000: first, the district self-sufficiency principle was abandoned; second, differences in separating and recycling waste among wards arose; third, the incineration of plastic waste began. Regarding the future prospects, at the waste collection stage, the door-to-door collection method is expected to spread among the special wards. Moreover, at the incineration disposal stage, although the district self-sufficiency principle was abandoned, fairness is expected to be maintained among the wards, using economic instruments and considerations to ensure a regional balance. It seems that the final disposal sites will be able accommodate waste for the next few decades by reducing waste generation, in addition to conducting ash melting and plastic incineration.

In the Tama area, municipalities established MSW management systems that aimed to dispose of waste appropriately against the background of urbanization in the 1960s. The majority of MSW disposed of in the dust boxes was incinerated in communal facilities, and the ash was deposited in the landfill site in Hinode Town. However, the municipalities were compelled to shift to a form of management that reduces disposal waste, as the remaining capacity of final disposal sites decreased significantly, and conflicts concerning sites with neighboring residents occurred in the 1990s. Therefore, some local municipalities in the Tama area, such as Hino City, implemented changes to their waste management systems, such as introducing charges for waste, and abolishing dust boxes, and succeeded in reducing waste for disposal. According to the results of my survey in Hino City’s residents, the biggest factors in waste reduction were introducing charges for waste collection and a door-to-door collection system. In the future, management aimed at reducing disposal waste will be maintained in the Tama area. However, this also carries issues of increased cost and diminished efficiency in collecting waste. In addition, the reduction in the remaining capacity of final disposal sites has been slowed by changing waste management and operating an eco-cement plant since 2006.

As can be seen from the discussion to this point, the waste problem that has troubled Tokyo is now under control, with the improvement in processing technology and the increase in citizens’ environmental consciousness. Waste management facilities’ harmful impacts upon the surrounding environment have mostly been eliminated, and they provide benefits to surrounding areas with their energy production capabilities (Tanaka 2005). Does this mean that waste issues are totally under control in Tokyo? Unfortunately, unresolved issues persist, such as the NIMBY syndrome, the higher financial burden through implementation of superior processing systems and new collection methods, and higher emissions of greenhouse gases associated with waste disposal.

It is clear that the provision of facility information (e.g., explanations of site location decisions, explanations of facility equipment, organizing facility tours, publication of the monitoring data on substances of concern, etc.) would help to alleviate the NIMBY syndrome (Matsuto et al. 2005; Kurishima and Takahashi 2014). However, information provision alone cannot resolve NIMBY. Matsuto et al. (2005) highlight that the reasons behind the NIMBY problem have many causes, such as the negative image of waste facilities and the backlash against siting of facilities near homes (especially if citizens feel this was enforced), in addition to worries regarding the environmental impact. Additionally, as in the case of Koganei City, some movements oppose the incineration process or the use of landfills itself, stemming from exaggerated expectations of recycling. It is necessary to provide benefits to the surrounding area, such as by continually providing energy and environmental learning experiences, to erase negative images and the backlash against the siting of nearby facilities. Regarding the criticisms of and oppositions to incineration or landfill disposal, it is important to quantitatively evaluate the limitations of recycling and to explain to citizens the necessity of processing facilities.

The increased costs associated with implementing superior disposal systems and the new collection methods, as well as the increase in greenhouse gases, show that the issue of waste will not be solved with better disposal technology and increased environmental consciousness alone. When we consider this from the product lifecycle perspective, unless we reduce the amount of input, no matter how advanced the disposal technology becomes, and despite waste reduction and recycling, it proves impossible to ultimately reduce the waste management cost or greenhouse gases emissions. To resolve such issues, besides waste management and disposal, we should also focus on promoting products with a longer lifecycle, which are easier to process or recycle, and on educate consumers not to purchase items that do not comply with such standards.

Acknowledgements I received cooperation and valuable materials and information for this chapter from the staff of Clean Authority of TOKYO and the Recycling Promotion Division of Hino City. I also wish to express my appreciation to residents in the case districts for their cooperation. Moreover, I wish to express my gratitude to Dr. Akira Tezuka and other teachers of the Institute of Life and Environmental Sciences, University of Tsukuba for their guidance throughout and proofreading.

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Chapter 17
Status of Tokyo: Comparing Tokyo with Major Cities of the World

Kazutoshi Abe

Abstract This chapter evaluates Tokyo's status among Japan's major cities and compares Tokyo with major cities of the world in terms of the concentration of head and branch offices of large private companies. The first main focus is on analyzing the number of head and branch offices in Japan from 1950 to 2010. Clearly, the largest number of head offices is found in Tokyo, which also hosts the large number of branch offices. The difference in status between Tokyo and Japan's other cities has increased in recent times. The chapter's second focus is to compare the situation in Tokyo with that in the major cities of the Republic of Korea, France, the United Kingdom (UK), Thailand, the United States of America (US), Germany, and India. Tokyo, Seoul, Paris, Bangkok, and London gravitate to the same category as capital cities with strength in terms of head and branch office locations. Conversely, within the US, Germany, and India, capital cities weaker in terms of numbers.

The important factor affecting these results is the political system. Namely, in the cases of federated states, capital cities have a lower status, whereas the capitals of non-federated states enjoy very high status.

Keywords Large private firm · Major cities of Japan · Major world cities · Tokyo · Political system

17.1 Introduction

Among Japanese cities, Tokyo stands out in all respects. As regards population, transportation, easy contact with foreign countries, number of universities, and cultural and scientific institutions, Tokyo is unparalleled. It has such great power of attraction because it is the capital city. However, its status leads to the so-called Tokyo problem, as such a high level of activity concentration is exposed to a high

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level of damage in the event of a natural disaster, such as an earthquake. The whole country would suffer from such a disaster.

This study assesses Tokyo's status among major cities of Japan, and then compares Tokyo with major world cities in terms of the concentration of head and branch offices of large private companies (Economic Planning Agency 1964).

The chapter's first main focus is analysis of Japan in the period from 1950 to 2010, using data recorded for 1950, 1960, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005, and 2010 (Abe 1991, 1996, 2014a, b, 2015). The concentration of head and branch offices in major cities is analyzed, with special attention paid to changes in Tokyo's status.

Second, from the same perspective, the major cities of the Republic of Korea, France, the UK, Thailand, the US, Germany, and India are examined and compared with Japan and Tokyo. However, since a comprehensive serial analysis of these countries is difficult, the comparison is based only on the newest data. In addition, due to the limited space available for this chapter, the types of industry of the economic central management function of every city are not mentioned. Analysis is limited to the number of head and branch offices and the number of employees.

17.2 Tokyo Assessed Through the Economic Central Management Function

17.2.1 Situation of Firms Selected for Study

As this chapter focuses on large private Japanese firms, it is necessary to determine which firms should be selected for study. While the study concentrates on the head and branch offices of private firms, it would be neither practical nor pertinent to study every private Japanese firm. It will suffice to study the head and branch offices of the largest private firms, since these are the firms that most significantly influence the Japanese economy overall. Accordingly, the study will be limited to those firms listed on the stock exchanges of Japan. They are rated as dominating and, in reality, dominate the country's economy.

Table 17.1 shows the type of industry of the listed firms. Although the number of listed firms increased steadily from 780 in 1950 to 2581 in 2005, no less than 139 firms had disappeared by 2010. During those 60 years, various factors influenced the Japanese economy. In simple keywords, those factors include: post-war destruction, reconstruction, rapid economic growth, oil crisis of the 1970s, slower economic growth, strong Yen, emergence of a bubble economy and its collapse, the Lehman shock, etc.

Variations in the number of listed firms reflect these circumstances. Although the number increased steadily during the period of rapid economic growth, the rate of increase significantly dropped during the 1970s, when two oil crisis occurred. Since the initial listing requirements were eased in 1996, the number of listed firms

Table 17.1 Types of industry of firms selected for study (Abe 2014a, b)

	1950	1960	1970	1975	1980	1985	1990	1995	2000	2005	2010
Mining, agriculture, fisheries	40	54	33	25	23	22	10	11	11	17	14
Construction	15	20	99	127	133	141	145	171	198	167	140
Food	51	66	94	95	97	101	109	126	134	122	103
Textiles	62	86	87	87	84	80	79	100	88	83	55
Paper and allied products	20	35	35	35	33	32	32	31	29	23	18
Chemicals, rubber goods and ceramics	139	196	249	252	249	248	275	287	297	292	290
Iron, steel and machinery	209	350	570	591	578	606	646	683	729	704	676
Commerce, trading and service	64	113	156	182	200	245	336	402	564	612	586
Banks, financial leasing, securities and insurance	64	133	80	123	129	141	175	188	181	174	155
Transportation, communication, television station, warehouse and real estate	92	128	115	141	133	139	148	157	172	288	304
Electronic power companies and gas companies	17	18	18	18	18	18	18	19	20	24	24
Others	7	17	40	43	44	44	64	66	77	75	77
Total	780	1216	1576	1719	1721	1817	2037	2241	2500	2581	2442

Sources: (1) The Annual Nikkei Japanese Company Report by the Nihon Keizai Shinbun Inc
(2) The State of Japanese Companies by Diamond Inc.
(3) Survey by the author

increased again until 2005. It then decreased for the first time from 2005 to 2010; the Lehman shock is a very probable cause. Consequently, many mergers and acquisitions have occurred in recent years.

Table 17.2 shows the variation of the ratio of each type of industry shown in Table 17.1. In 2010, the sector displaying the highest ratio (27.7%) is "steel and machinery." Combined with "chemical, rubber goods, and ceramic industries" (11.9%), this sector of heavy and chemical industries still groups 39.6% of all Japanese firms. Nevertheless, this sector was at its peak in 1970 with 52.0%, being the leading sector of the rapid economic growth of the 1960s, and has been declining since then. Continuously increasing is the "commerce trading and services" sector, starting at 8.2% in 1950 and reaching 24.0% in 2010. The sector of "transportation, information, communication, warehousing, and real estate," which already exceeded 10% in 1950 and 1960, stagnated at around 7% from 1970 to 2000, but then displayed a sharp increase from the beginning of the twenty-first

Table 17.2 Type of industry of firms selected for study (percentage) (Abe 2014a, b)

	1950	1960	1970	1975	1980	1985	1990	1995	2000	2005	2010
Mining, agriculture, fisheries	5.1	4.4	2.1	1.5	1.3	1.2	0.5	0.5	0.4	0.7	0.6
Construction	1.9	1.6	6.3	7.4	7.7	7.8	7.1	7.6	7.9	6.5	5.7
Food	6.5	5.4	6.0	5.5	5.6	5.6	5.4	5.6	5.4	4.7	4.2
Textiles	7.9	7.1	5.5	5.1	4.9	4.4	3.9	4.5	3.5	3.2	2.3
Paper and allied products	2.6	2.9	2.2	2.0	1.9	1.8	1.6	1.4	1.2	0.9	0.7
Chemicals, rubber goods and ceramics	17.8	16.1	15.8	14.7	14.5	13.6	13.5	12.8	11.9	11.3	11.9
Iron, steel and machinery	26.8	28.8	36.2	34.4	33.6	33.4	31.7	30.5	29.2	27.3	27.7
Commerce, trading and service	8.2	9.3	9.9	10.6	11.6	13.5	16.5	17.9	22.6	23.7	24.0
Banks, financial leasing, securities and insurance	8.2	10.9	5.1	7.2	7.5	7.8	8.6	8.4	7.2	6.7	6.3
Transportation, communication, television station, warehouse and real estate	11.8	10.5	7.3	8.2	7.7	7.6	7.3	7.0	6.9	11.2	12.4
Electronic power companies and gas companies	2.2	1.5	1.1	1.0	1.0	1.0	0.9	0.8	0.8	0.9	1.0
Others	0.9	1.4	2.5	2.5	2.6	2.4	3.1	2.9	3.1	2.9	3.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: See Table 17.1

century, due to the multiplication of information-related businesses. The majority of Japanese firms are now found in the tertiary industries group.

17.2.2 Major Japanese Cities Evaluated by Number of Head Offices

Table 17.3 shows the number of head offices located in the major Japanese cities from 1950 to 2010. During that period, almost half of major companies located their head offices in Tokyo.

Table 17.3 Number of head offices located in major cities of Japan from 1959–2010 (Abe 2014a, b)

	1950	1960	1970	1975	1980	1985	1990	1995	2000	2005	2010
Number of firms chosen	780	1216	1576	1709	1721	1817	2037	2241	2500	2581	2442
Tokyo	413	595	765	783	786	823	894	919	1001	1088	1072
	(52.9)	(48.9)	(48.5)	(45.8)	(45.7)	(45.3)	(43.9)	(41.0)	(40.0)	(42.2)	(43.9)
Osaka	113	185	237	249	249	256	291	314	361	340	309
	(14.5)	(15.2)	(15.0)	(14.6)	(14.5)	(14.1)	(14.3)	(14.0)	(14.4)	(13.2)	(12.7)
Nagoya	24	45	65	63	63	71	81	88	98	103	98
	(3.1)	(3.7)	(4.1)	(3.7)	(3.7)	(3.9)	(4.0)	(3.9)	(3.9)	(4.0)	(4.0)
Yokohama	19	24	33	32	35	35	40	50	58	64	61
	(2.4)	(2.0)	(2.1)	(1.9)	(2.0)	(1.9)	(2.0)	(2.2)	(2.3)	(2.5)	(2.5)
Kobe	28	43	33	40	39	44	46	57	59	42	46
	(3.6)	(3.5)	(2.1)	(2.3)	(2.3)	(2.4)	(2.3)	(2.5)	(2.4)	(1.6)	(1.9)
Kyoto	16	21	31	35	38	39	41	48	55	48	46
	(2.1)	(1.7)	(2.0)	(2.0)	(2.2)	(2.1)	(2.0)	(2.1)	(2.2)	(1.9)	(1.9)

Source: See Table 17.1

Although the head office ratio of Tokyo has been constantly decreasing from 52.9% in 1950, it rose to 42.2% in 2005, then to 43.9% in 2010, despite a decrease of the total number of head offices.

Conversely, the number of head offices located in Osaka increased continuously during the period, reaching a ratio of about 14%. However, since the beginning of the twenty-first century, a reduction in the head offices ratio has occurred, dropping to 13.2% in 2005, and further to 12.7% in 2010. A large number of head offices remain located in other cities, such as Nagoya, Yokohama, Kobe, and Kyoto. Since 1960, Nagoya has had the 3rd largest number of head offices (45 head offices, 3.7% in 1960; 103 head offices, 4% in 2005). Despite a decrease in that number to 98 head offices in 2010, Nagoya's overall ratio remains approximately 4%.

It must be noted that the number of head offices data presented in Table 17.3 is based on firms' location of registration. A significant number of major Japanese companies have adopted a system of multiple head offices (generally two; rarely three), where the second head office becomes the *de facto* head office, with the registered head office operating as a branch.

Table 17.4 shows the number and the location of multiple head offices from 1960 to 2010. Only 17 companies had multiple head offices in 1960 (1.4% of all companies). In 1990, 263 companies had adopted that system (12.9% of all companies). More companies adopted that system up to 2005, though the proportion was lower than before, as revealed by a slight drop in their ratio (11.7%). However, the number of such companies had fallen quite sharply in 2010 (201 companies, 8.2%).

In this regard, a case that warrants attention is that of companies having their first head office registered in Osaka and their second head office located in Tokyo. There were no such companies in 1960, then 22 appeared simultaneously in 1970. The

Table 17.4 Multiple head offices system of major companies (Abe 2014a, b)

First head office (legally registered)	Second head office	1960	1970	1980	1985	1990	1995	2000	2005	2010
Osaka	Tokyo (23 wards)	0	22	31	32	67	83	96	96	70
Other cities	Tokyo (23 wards)	9	36	63	65	112	103	124	111	78
Tokyo (23 wards)	Osaka	0	1	0	0	6	8	9	8	19
Cities other than Tokyo (23 wards)	Osaka	6	14	19	22	18	18	11	17	3
Other cases		2	13	11	12	60	54	52	71	31
Total (a)		17	86	124	131	263	266	292	303	201
Number of the firms which are included in the study (b)		1216	1576	1721	1817	2037	2241	2500	2581	2442
(a)/(b) × 100		1.4	5.5	7.2	7.2	12.9	11.9	11.7	11.7	8.2

Source: See Table 17.1

number of such companies peaked at 96 in 2005, then dropped to 70 in 2010: a not insignificant number. If we reconsider the calculation of head offices taking that point into consideration, there were 1286 head offices located in Tokyo in 2005 (49.8%) and 1189 (48.7%) in 2010. In Osaka, there were 247 head offices in 2005 (9.6%) and 259 (10.6%) in 2010. Finally, in Nagoya, there were 97 head offices in 2005 (3.8%) and 96 (3.9%) in 2010.

Undeniably, despite an increase in the number of head offices in Osaka in 2010, the trend is oriented toward a reduction. Since many companies that have adopted the system of multiple head offices are based in Osaka, it is very likely that the gap between Tokyo and Osaka will widen. From a managerial perspective, the decline in Osaka is striking.

17.2.3 Major Japanese Cities Evaluated by Number of Branch Offices

Table 17.5 shows the variation in the number of branch offices located in major cities from 1950 to 2010. The numbers presented in the table are the actual numbers of firms locating at least one branch office in each city. For example, 1346 in Tokyo in 2010 means that 1346 firms of the 2442 have at least one branch office located in Tokyo.

When reviewing the variation in the number of branch offices, some important points can be identified. First, since the twenty-first century, the number of branch offices in every city is also decreasing, despite an overall increase of 81 firms between 2000 and 2005. From 2005 to 2010, with the disappearance of 139 firms, the number of branch offices in every city shrank at a much faster pace. At the beginning of the twenty-first century, the environment surrounding corporate management was particularly harsh in Japan, with the collapse of the bubble economy and the subsequent Lehman shock.

Table 17.5 Number of branch offices located in major cities of Japan from 1950 to 2010 (Abe 2014a, b)

	1950	1960	1970	1975	1980	1985	1990	1995	2000	2005	2010
Number of firms chosen	780	1216	1576	1709	1721	1817	2037	2241	2500	2581	2442
Tokyo	401	645	944	1090	1091	1165	1355	1514	1627	1610	1346
Osaka	390	668	1012	1108	1069	1115	1266	1377	1484	1430	1206
Nagoya	221	511	870	967	974	1034	1192	1348	1456	1393	1157
Fukuoka	192	368	614	736	772	846	1018	1182	1241	1185	954
Sendai	101	223	478	614	685	727	913	1035	1129	1076	850
Hiroshima	87	209	511	626	656	718	854	967	1028	959	736
Sapporo	150	348	568	656	703	738	847	961	1010	960	721
Yokohama	96	141	263	308	343	397	587	657	757	714	548

Source: See Table 17.1

Another point is the emergence and multiplication of holding companies since the beginning of the twenty-first century: 148 of 2442 firms belong to this category, among which 79 firms did not have branch offices in 2010. This is another cause of the reduced number of branch offices in every city. However, since a given firm has a legal existence under the holding umbrella, from a practical perspective, these branch offices should be observed in every city. This matter causes a significant problem for urban studies, from the perspective of the economic central management function.

17.3 Dominance of Tokyo Evaluated by Number of Employees

Our comparison among major Japanese cities has, to this point, been conducted considering the economic central management function, i.e., the number of head and branch offices of firms and their industry types. The chapter now undertakes an analysis regarding the number of employees of head and branch offices. While both belong to the economic central management function, the roles (functions) of head and branch offices differ. Head offices supervise the activities of the firm as a whole, while the role of branch offices is business and trade. Therefore, though it is desirable to assess the contents and levels of authority of head and branch offices, this is an almost impossible task. Alternatively, this chapter approaches this question by considering the number of employees of head and branch offices.

Table 17.6 shows the number of registered head offices in major cities in 2010 (A), the number of branch offices (D), the average number of employees per head office in every city (B), the average number of employees per branch office (E), etc. Each firm's total number of employees is sourced from their "annual security report"; however, the numbers of employees in head and branch offices cannot be

Table 17.6 Estimated number of employees at head and branch offices in major cities of Japan in 2010 (Abe 2014a, b)

	A	B	C = A × B	D	E	F = D × E	G = C + F	H
Tokyo	1072	391.8	420,009.6	1346	126.4	170,134.4	590,144.0	100.0
Osaka	309	173.2	53,518.8	1206	98.1	118,308.6	171,827.4	29.1
Nagoya	98	129.5	12,691.0	1157	71.7	82,956.9	95,647.9	16.2
Fukuoka	34	117.6	3998.4	954	60.9	58,098.6	62,097.0	10.5
Sendai	10	213.9	2139.0	850	43.4	36,890.0	39,029.0	6.6
Hiroshima	13	251.8	3273.4	736	47.3	34,812.8	38,086.2	6.5
Sapporo	25	134.1	3352.5	721	34.2	24,658.2	28,010.7	4.7
Yokohama	61	334.3	20,392.3	548	69.4	38,031.2	58,423.5	9.9

Source: The Japanese Ministry of Finance by the firms under study
Notes:
Cities are ranked by the value of (H)
A. Number of head offices
B. Average number of employees in head offices
C. C = A × B
D. Number of branch offices
E. Average number of employees in branch offices
F. F = D × E
G. G = C + F
H. In column G, Tokyo is given the base value of 100.0

obtained for all firms because publication of these numbers is not compulsory. Therefore, the B and E numbers have been calculated based on the numbers of employees published by a large sample of the studied firms. Therefore, each total (C = A × B) for number of employees in head offices and each total (F = D × E) for number of employees in branch offices is an estimated number based on a sample of firms[1].

First, considering the average number of head office employees, the number for Osaka only represents 12.7% of the number for Tokyo, despite the fact that, by number of head offices, Osaka has 28.8% of Tokyo's number (Osaka: 309, Tokyo: 1072), which is a significantly wide gap. Ranking third is not Nagoya (3%) but Yokohama (4.9%). Although more head offices are located in Nagoya, they employ fewer people than the head offices located in Yokohama. This suggests that many large-scale firms have their head offices in Yokohama.

[1] Since firms are not expressly required to provide a statement about the total number of employees working in all their facilities in their "annual security report," data concerning every firms' total number of employees in all facilities cannot be obtained. Consequently, this study only uses data from firms that publish their total number of employees. When the author concretely describes the case of Tokyo, the overall total of employees in the head offices of firms whose data are published amounts to 298,525 employees for 762 firms, an average of 391.8 employees per head office. Extrapolating from this, if the 1072 head offices located in Tokyo are multiplied by that average, a total of 420,009.6 employees is reached. The number of employees in head offices being a sample of 762 firms (71.1% of 1072 firms), an estimated number of employees slightly above 420,000 is obtained. This is the meaning of the term "estimated number" in the chapter. The average number of employees in head and branch offices located in other cities are also calculated using the same method.

Regarding the average number of branch office employees, compared to Tokyo, the ratio for Osaka is 69.5%, while it is 48.8% for Nagoya. By number of branch offices, Osaka has 89.6% of Tokyo's number, while Nagoya has 86.0%. Thus, the gap between Tokyo and the other cities is not as wide as for head offices, but is nonetheless important. Except for Sapporo, all other cities' ratios exceed 20.0% of Tokyo's figures: Fukuoka: 34.1%; Yokohama: 22.4%; Sendai: 21.7%; and Hiroshima: 20.5%.

When adding up the average number of head office employees and branch office employees, the highest number is naturally found in Tokyo. Osaka ranks second, with a number representing only 29.1% of that for Tokyo. Nagoya and Fukuoka follow, with respective ratios of 16.2% and 10.5% of Tokyo's number. The gap between Tokyo and other Japanese cities is clearly very wide.

Considering the case of multiple head office firms and counting one registered head office as a branch office, the gap between Tokyo and the other cities in the number of employees of head and branch offices becomes even wider: as a proportion of Tokyo's number, Osaka is at 26.3%, Nagoya 15.2%, Fukuoka 9.9%, and Yokohama 8.7%.

Table 17.7 shows the variation from 1960 to 2010 in the estimated number of employees of head and branch offices in major cities compared to Tokyo. Since the average number of employees is based on a sample, instead of all firms, it presents a problem of numerical reliability; nonetheless, for an historical approach, it still can point to a general trend that may be summarize in the following four points.

1. Although Tokyo's dominance has been strong from the beginning of the period, it intensified remarkably in recent years.
2. The economic central management activities in Osaka peaked in 1970 and have been in decline ever since.
3. The economic central management activities of major Japanese cities, except Kobe and Yokohama, also peaked in 1970. The peak year of the period of rapid economic growth can be considered to be 1970, when branch offices of major firms were located in many cities, such as Sapporo, Sendai, Hiroshima, and Fukuoka (Table 17.5).
4. The author's approach of considering the second head office located in Tokyo as the *de facto* main head office reveals a further increase in Tokyo's dominance.

As noted above, it can be observed that Tokyo's degree of dominance is very strong and has been growing even stronger in recent years, thereby contributing to Osaka's rapid decline.

What are the principal causative factors? The fullness of the urban function of Tokyo, particularly the high-level concentration of major firms' head offices, has been widely recognized, but the most important point is the might of Tokyo's political function as the capital city. This has long been the principal factor attracting economic central management activities to Tokyo.

Economic depression hit Japan after the oil crisis of the 1970s, then struck again in the 1990s; only now is it receding. Although detailed proof is difficult to obtain, the political function is considered so important that Tokyo's status has been strengthening during every depression.

Table 17.7 Number of employees at head offices and branch offices in 8 cities: percentages of Tokyo (Abe 2014a, b)

	1960	1970	1980	1985	1990	1995	2000(a)	2000(b)	2005(a)	2005(b)	2010(a)	2010(b)
Tokyo	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Osaka	55.2	59.6	45.5	38.8	63.0	37.3	34.7	30.7	30.5	26.1	29.1	26.3
Nagoya	19.4	26.0	19.8	17.3	16.8	16.9	18.4	17.0	17.3	15.5	16.2	15.2
Fukuoka	5.7	8.9	14.0	11.0	9.1	11.2	13.2	12.4	13.1	11.9	10.5	9.9
Yokohama	12.8	10.5	12.8	9.3	8.2	9.8	11.0	10.2	13.1	12.0	9.9	8.7
Sendai	4.8	5.7	9.7	7.3	7.0	8.1	10.2	9.6	9.0	8.1	6.6	6.2
Hiroshima	3.8	7.2	8.7	7.5	6.1	6.8	8.4	7.8	8.1	7.3	6.5	6.0
Kobe	12.1	8.6	7.1	7.4	5.6	6.1	8.2	7.3	7.8	7.0	6.4	6.0
Sapporo	6.1	7.4	8.5	6.8	5.8	6.6	6.6	6.2	7.0	6.3	4.7	4.5

Source: The annual company security report
(a) The second head offices are evaluated as branch office
(b) The first head offices (legally registered) are evaluated as branch offices

17.4 Comparison with Major World Cities

Having completed a comparative examination of major Japanese cities from 1950 to 2010 through the economic central management function, this chapter now undertakes to compare Tokyo with other major world cities. Since it is difficult to obtain the same level of data as for Japan, spanning a long time period, gathered information is insufficient. The author's analysis is, therefore, based upon relatively new data about the following countries: the Republic of Korea (Abe 2005), France (Abe 2009), the UK (Abe 1996), Thailand (Abe 2001), the US (Abe 1996), Germany and India (Abe 2010).

Regarding head offices, the concentration ratios are 52.9% in Seoul, 21.8% in Paris, 25.7% in London, 92.7% in Bangkok, 4.4% in New York, 4.2% in Berlin, and 22.6% in Mumbai. When the urban spheres of influence of Seoul, Paris, and London are considered, the level of concentration of head offices reach 75.1% in Seoul, 46.7% in Paris, and 47.5% in London, which are all notably high levels. In these countries, the second ranking cities are Pusan in the Republic of Korea (4.8%), Lyon in France (1.5%), and Birmingham in the UK (2.7%), significantly lower than the ratios of the first cities, and well below the level of Osaka (around 12%), for example. Conversely, in the US, Germany and India, the second ranking cities are Chicago (2.3%), Hamburg (6.0%), and Delhi (10.9%).

Regarding branch offices, Seoul, Paris, London, and Bangkok display, by huge extents, the highest concentration levels. In the US, Chicago is the highest-ranking city. In Germany and India, the capital cities (Berlin and Delhi, respectively) have the highest levels of branch office concentration, but the gap between them and the second ranking cities is not as wide as in other countries.

The situation can be summarized up as follows.

1. Capital cities display the highest level of head office concentration in Japan, the Republic of Korea, France, the UK. and Thailand, but cities other than capital cities rank first in the US, Germany, and India.
2. The highest level of branch office concentration is found in capital cities in every country except in the US. In Germany and India, the gap between the first and second ranking city is small.

The key factor in these findings appears to be each country's political system. In countries with a non-federal political system, capital cities show the highest level of concentration of head and branch offices; conversely, in countries with a federal system, capital cities do not have the highest concentration level in either category. With reference to these concentration levels, then, there is a definite relation between a country's political system and the ranking of its cities.

17.5 Conclusion

From the perspective of high-level urban functions, such as the economic central management function, high-ranking world cities fall into two categories: capital cities and non-capital cities. Tokyo has been the capital of Japan for more than 100 years, since the Meiji era, and has always been highly ranked in Japan's economic central management function. Ranking second, Osaka resisted Tokyo's dominance for a long period of time, but has lately been irreversibly declining against the capital. Similar to Japan, the highest-ranking cities that are capitals are found in the Republic of Korea, France, the UK, and Thailand. Conversely, the capital cities of the US, Germany, and India are not the highest-ranking cities in their respective countries with regard to the concentration levels of large private companies' head and branch offices.

The factor invoked to explain this difference is a country's political system; however, the list of countries studied in this chapter is not sufficiently exhaustive to draw firm conclusions and countries that advocated socialism, such as Russia and China, are not included in the study. Moreover, the stage of development of the history and economy of a country can hugely affect the concentration of the economic central management function in its major cities. A more synthetic examination is a subject for future research.

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In Place of a Conclusion: Where Is Tokyo?

Toshihiko Sugai

Where Is Tokyo Located?

The chapters in this volume show that the geography of Tokyo presents many different faces and that it has changed dynamically through geologic time. Here, let us return to our starting point by overviewing Tokyo at different geographical scales, seeking the common factors, amid its diversity, that have sustained this great city. Local and regional conditions are fundamental to the identity of where we live, and they sometimes impose sharp constraints on the resulting communities.

The site of Tokyo is one of steep environmental gradients, where contrasting natural environments meet at various scales. At the global scale, Tokyo is situated between the tropical and polar climatic zones, and between the great Eurasian continent and the even greater Pacific Ocean (Fig. 1a). Therefore, Tokyo is affected by a temperate monsoon climate with four seasons, and influenced by major ocean currents. In tectonic terms, Tokyo lies in the circum-Pacific orogenic zone, where the largest continental plate and the largest oceanic plate converge. This explains why Tokyo has frequent earthquakes.

At the regional scale, Tokyo is in the southwestern part of the northeastern Japan island arc. The elevation difference between Tokyo and the deepest part of the Japan Trench exceeds 8000 m, comparable to that between the Himalayas and the Indo-Gangetic Plain. Subduction of the Pacific Plate has generated the volcanic front of northeastern Japan, along with hot springs, such as Kusatsu, Hakone, and Nasu near Tokyo. Frequent volcanic eruptions and even more frequent river flooding have supplied abundant parent materials for the deep and fertile soils of the Kanto Plain.

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At the local scale, Tokyo lies in the central part of the Kanto Plain and faces Tokyo Bay (Fig. 1b). The geologic forces that formed the Kanto sedimentary basin produced a coastal environment in which sediment-laden rivers have built highly productive estuarine habitats between the Kanto Plain and Tokyo Bay. In Tokyo, too, frequent land and sea breezes ameliorate the urban climate.

At the micro scale, the western half of downtown Tokyo was developed on uplands and the eastern half on lowlands (Fig. 1c). On the uplands, the so-called Yamanote (literally "toward the mountains") grew around the residences of the samurai class. On the lowlands, the so-called Shitamachi (literally "low town") was where common people lived in traditional partitioned houses. After the 1923 Great Kanto Earthquake and World War II, urban Tokyo expanded rapidly, accompanied by gentrification of the downtown that weakened the socioeconomic distinction between the two areas. The uplands and lowlands, defined by the steep slopes between them and an elevation difference of about 20 m, remain today as elements of landscape diversity.

In sum, Tokyo's location sits in a hierarchy of geographic structures characterized by binary opposites: continent versus ocean, land versus sea, and upland versus lowland. Next, let us stand upon the tip of Tokyo's upland and observe, from there, the city's pattern of historical growth.

Where Is Tokyo from?

Urban Tokyo has expanded in all directions since the nineteenth century while its center has remained along the boundary between upland and lowland, where the eastern half of the Yamanote railway line runs (Fig. 2). The plateau of the uplands has been partly dissected by stream valleys, leaving remnant headlands that protrude like capes into the lowland basin. From north to south among these capes, we can spot Asukayama Park, Ueno Park, Tokyo Imperial Palace, and Omori Shell Mounds, representing the historical background of Tokyo (Fig. 1c).

The Omori Shell Mounds, formed in the prehistoric Jomon period, is located on the southern part of the upland. These were the first shell mounds to be discovered in Japan, and were initially described by Edward S. Morse in 1877. The distribution of ancient shell mounds allowed Toki Ryu-shichi, in 1926, to reconstruct the paleogeography of the Kanto Plain during the Jomon transgression, or "period of high sea level," about 7000 years ago. At that time, the waters of Tokyo Bay lapped against the indented shoreline just below the eastern edge of the upland, and Shitamachi was under the sea. Local people depended on marine resources, such as clams and fish, along with nuts and animals. During the following few thousand years, the deltas of the local rivers extended southward onto the Tokyo Lowland. As the sea receded, this delta sediment became fertile soil supporting paddy fields, which became a major food source during the historical Edo period (1603–1868).

Asukayama Park, in the northern part of the upland capes, is famous for its cherry blossoms. Many excellent views from this park were depicted by Hiroshige Utagawa, the great *ukiyo-e* artist of the Edo period (Fig. 3). One such view overlooks the

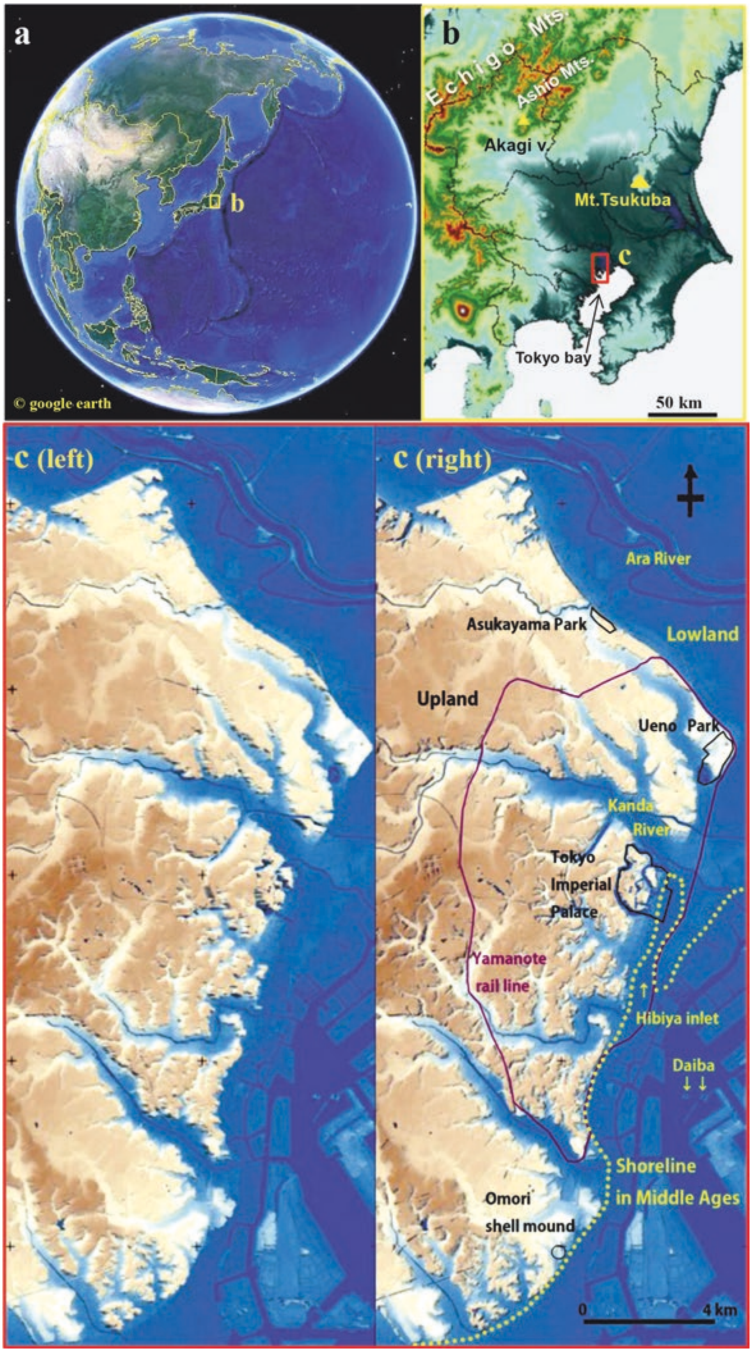

Fig. 1 Tokyo at different geographical scales. (**a**) Tokyo on the global scale; (**b**) Regional setting of Tokyo in the Kanto Plain; (**c**) Downtown Tokyo. (**a**) after US Dept. of State Geographer ©2016 Google ©2009 GeoBasis-DE/BKG. (**c**) DEMs are provided by Geospatial Information Authority of Japan

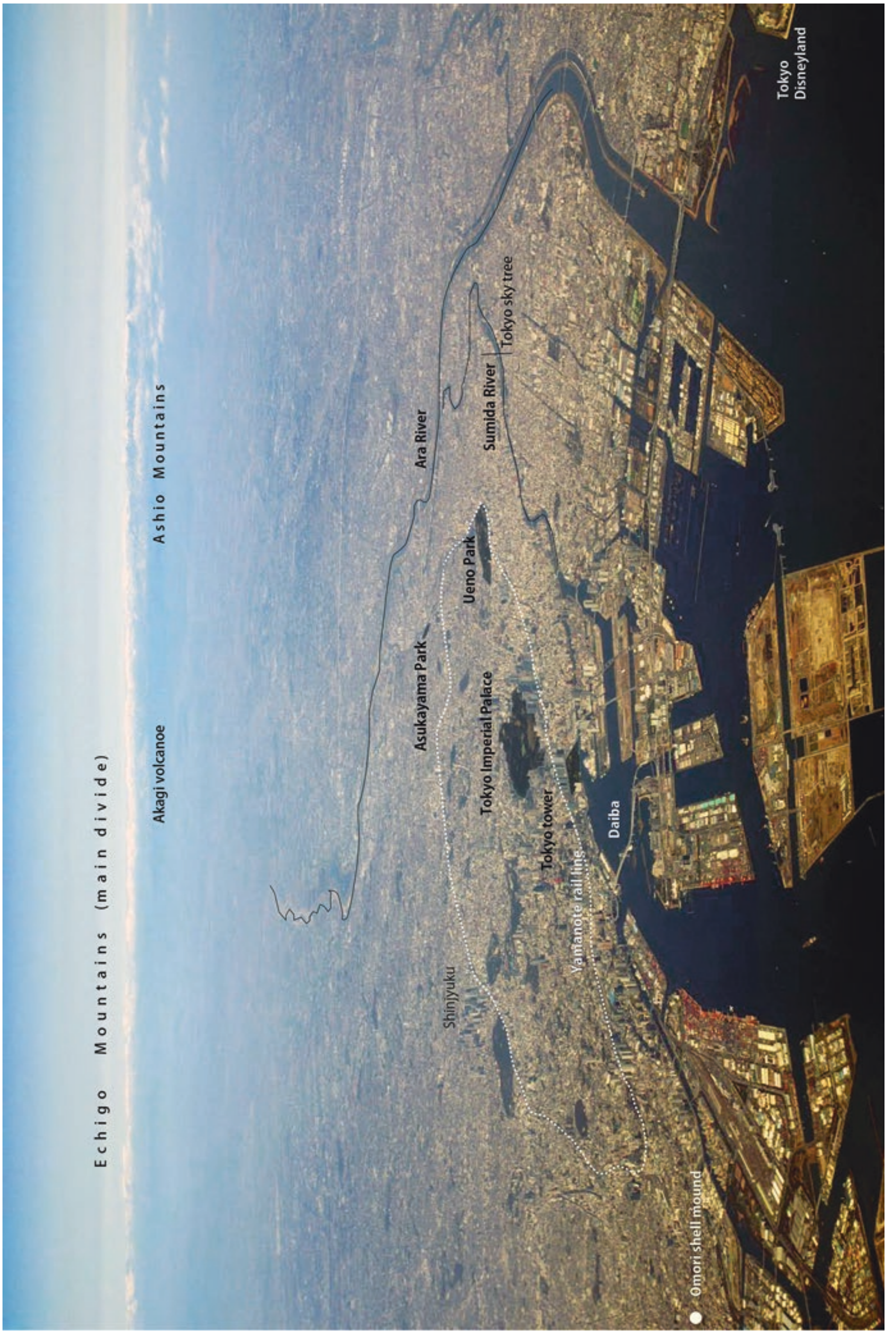

Fig. 2 View north from above Tokyo Bay (Photographed by Sugai 2009)

Fig. 3 View northeast from Asukayama Park, interpreted by Utagawa Hiroshige. Mt. Tsukuba is seen across the Kanto Plain

low-lying paddy fields of the Kanto Plain, with graceful Mt. Tsukuba in the far distance. Before the twentieth century, the rivers in the Kanto Plain were major transport routes for goods and people that supported many flourishing port towns.

The Tokyo Imperial Palace is at the center of the upland capes. From the palace, signs can be seen of the turbulent times marking the end of national isolationism. The Palace began as a castle founded by Ota Dokan in 1457, and was used as the residence of the shogun during the Edo period. Early in the seventeenth century, Tokugawa Ieyasu expanded the castle by filling an inlet named Hibiya Irie on its southeastern side, making it the largest Castle in Japan. In the late Edo period, a set of small islands was constructed in front of the Palace to house artillery batteries, or *daiba*, to defend the isolationist regime from Western naval incursions (Fig. 1c). The need for the *daiba* ended with the reopening of Japan to the world, when the Edo period gave way to the Meiji period. Today, only two of the islands remain, reminding visitors of historian Arnold Toynbee's judgment that the modernization of Japan during the Meiji period was one of the economic miracles of human history. Their survival amid today's urbanization also suggests that the future Tokyo will be a mixture of historical and contemporary features beyond our imagination.

Ueno Park is north of the Imperial Palace, across the valley of the Kanda River that dissects the Yamanote Upland. This park is also famous for cherry blossoms, as well as its museums, especially the National Museum of Western Art, designed by Le Corbusier. Visitors find the fusion of cultural opposites in Ueno Park, such as east versus west and modernism versus traditionalism, an everlasting source of stimulation.

Where Is Tokyo Going?

The concentration of natural resources in the Kanto Plain, under the influence of the monsoon climate and tectonic activity, has helped Tokyo become the world's most populous metropolis. The city's abundance of water and soil sustains a vigorous urban metabolism that coexists with environmental diversity. These same natural elements also have the potential to produce natural disasters, such as flooding, earthquakes, tsunamis, liquefaction, and volcanic eruptions. The people of Tokyo, with a history of courage and cooperation, have survived these natural disasters and recovered from their damage and destruction.

The landscape of Tokyo has a history of dramatic change, yet Tokyo preserves a long and rich history, woven by the interaction of human society and the natural environment. The sharing of tacit inherited knowledge, such as the traditional lifeways of the partitioned houses of the Edo period, underlies a culture that values wise adaptation to the natural environment, wise use of natural resources, and living daily life in cooperation with nature. Thus, our Tokyo lifestyle may serve as a guidepost toward a spiritually rich city in the future.

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