Chapter 18
Restoration of the Urban Forests of Tokyo and Hiroshima Following World War II

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Abstract The urban forests of Tokyo and Hiroshima were devastated by American bombing during World War II. Approximately 160 km^2 of Tokyo were burned by more than 100 fire bombings, while an area of 12 km^2 was leveled and burned by one atomic bomb in Hiroshima. Tokyo's street tree population was reduced from 105,000 to approximately 42,000 by the end of the war. In the years immediately following the war, the street tree population dropped to 35,000 in Tokyo due to a combination of further tree mortality and the cutting of trees for fire wood. No estimates of pre-war street tree populations are available for Hiroshima. Examination of pre-and post-atomic bombing photographs of Hiroshima suggests an even higher percentage of the trees in the city were destroyed. Post-war reconstruction of the urban forests of each city developed along different pathways. Plans for the redevelopment of Tokyo were rejected by the general public who wanted a return to pre-war conditions. Few streets were widened to accommodate traffic and allow for new street tree-planting. Plans for new parks were shelved or only partially achieved. Some streets were replanted by private citizens. Initial survival rates of replanting were low. Trees in Tokyo's municipal tree nurseries, which had not been converted to vegetable gardens during the war, were often larger than the optimal size for transplanting, but were used as no other trees were available. A more concerted effort to reconstruct the urban forest came following the 1959 decision to site the 1964 Olympic Games in

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K.G. Tidball and M.E. Krasny (eds.), *Greening in the Red Zone: Disaster, Resilience and Community Greening*, DOI 10.1007/978-90-481-9947-1_18,

Tokyo. Many streets were widened and planted with trees. New tree-lined boulevards were also created. In contrast, Hiroshima sponsored an international competition for the design of a Peace Park and a major tree-lined boulevard. Several wide streets were built with space for street trees. Major plans were also drawn to create greenways along the rivers and to build additional parks. Trees were initially donated by local farmers and nearby towns for planting the parks and the boulevard since municipal tree nurseries had been converted to vegetable gardens during the war. Survival rates were very low due to the rubble content of the soil and difficulties in watering the transplanted trees. Strong support from the mayors of Hiroshima contributed to the success of urban forest reconstruction in Hiroshima. The historical significance of the destruction caused by the first atomic bomb to be dropped on an urban area also contributed to Hiroshima citizens' will to reconstruct both the city and its urban forest. Species and location of trees determined the survival of trees after war in both cities. Species with strong resprouting ability and thick bark survived the bombing and fire. In Tokyo trees located in open areas avoided the fire, while in Hiroshima trees standing behind tall concrete buildings were shielded from radiation and the heat wave. In addition to the difficulties faced during the city-wide replanning process, constraints of urban forest recovery included severe financial restriction, short supply of proper large-sized trees for planting and lack of labor for planting and post-planting tree care. Hiroshima used public participation and community involvement to restore the urban greenery successfully and, until today, has maintained a program to conserve the trees that survived the atomic bomb.

Keywords History • Japan • Post war-city planning • Replanting • Trees • Urban forest

Sheauchi Cheng of the US Department of Agriculture and American forest ecologist Joe McBride compare destruction and rebuilding of the urban forest in Tokyo and Hiroshima after World War II. They note that whereas Tokyo focused more on reconstructing the built environment, Hiroshima, which suffered the immense destruction of the atomic bomb and whose reconstruction became a symbolic rallying point for the Japanese and for the international peace movement, was successfully able to restore and recreate an urban forest. This chapter has been adapted for this book from an earlier version in Urban Forestry and Urban Greening,[1] *with permission.*

Introduction

This study presents a case of greening in the red zone by documenting the restoration of the urban forests of Tokyo and Hiroshima following the destructive bombing of these cities during World War II. The study will contrast the impacts of fire bombing

[1] *Urban Forestry and Urban Greening*. Volume 5, Issue 4, 1 December 2006, pp. 155–168.

in Tokyo with the atomic bombing of Hiroshima on urban forest composition and structure. It will explore the planning processes used in each city for rehabilitation following the war, the replanting of trees, and the management of surviving trees. Information for this study was obtained through library research, review of city-planning documents, discussions with city planners and arborists in Tokyo and Hiroshima, and surveys in both cities to locate and observe the conditions of trees that survived the American bombings in World War II and the characteristics of the reconstructed urban forests.

Cities have been subject to destructive events of both natural and human origin throughout history (Mitchell 1999; Tung 2001; Ockman 2002; Pelling 2003; Vale and Campanella 2005). These events include volcanic eruptions, earthquakes, fires, hurricanes, typhoons, floods, landslides, tsunamis, terrorism, urban riots, and warfare. The nature and extent of the rebuilding of a city after a destructive event has varied with the type of destruction, resources available, and political leadership. The eruption of Vesuvius so completely destroyed the city of Pompeii in 79 AD that no attempt was made to rebuild it. In contrast, the city of St. Pierre on the Island of Martinique was rebuilt after its destruction by the eruption on Mount Pelee in 1902. The rebuilding of cities after natural disasters has not necessarily resulted in improved urban designs. Following the famous London fire in 1666, both Sir Christopher Wren and John Evelyn produced innovative plans for the rebuilding of London. The plans were rejected by Charles II as too extensive and impractical (Waller 2004). Destructive events in the twentieth century have continued to impact urban areas. Regrettably, twentieth century warfare led to levels of urban destruction rivaled by the destruction of cities in the Kwarazmian Empire by Mongol armies in the thirteenth century AD (Weatherford 2004) or the destruction of Atlanta and other southern cities by the Union Army during the American Civil War (Hirshson 1997).

Studies devoted to the rebuilding of cities after both natural and man-made events have focused primarily on urban planning and architecture (Rosen 1986; Bullock 2002; Hein et al. 2003; Vale and Campanella 2005). These works, with the notable exception of the studies presented in this volume, have paid little attention to the reconstruction of urban forests following the destruction of cities, although some works address open space and park planning (Morris 1997). The replacement of portions of urban forests destroyed by either natural or man-made forces has been part of large scale urban rehabilitation plans, and has also involved the actions of individuals in the restoration of trees in both public and private spaces.

The degree to which trees have been destroyed and damaged is dependent upon the nature of the destructive force and the tree species involved. How surviving trees have been treated in the restoration of urban forests has varied with the nature of the disaster, degree of injury to the trees, and the level of urban planning.

The end of the twentieth century and the beginning of the twenty-first century has not seen the end of the destruction of urban areas by natural forces or war. Extensive areas of New Orleans were damaged by winds and flooding resulting in the loss of trees (Nossiter 2005; see also Tidball Chap. 20, this volume). Trees in Sarajevo (Bosnia-Herzegovina), Grozny (Chechnya, Russian Federation) and in cities

in Iraq, Afghanistan, Palestine, and Lebanon have recently been subjected to bombing and artillery fire (see Laćan and McBride, Chap. 22, this volume). It is hoped that this study can identify patterns that can inform the discourse around greening in the red zone and the process of urban forest restoration following the current conflicts in the Middle East and other parts of the world. The results of this study will also be applicable to the restoration of urban forests following destructive natural events.

The Bombing of Tokyo and Hiroshima

The American aerial bombing of Japanese cities began on April 18, 1942 with an attack on Tokyo known as the Doolittle Raid. The bombs dropped during this raid were conventional bombs, not designed to create urban fires. Once the US forces had captured various Pacific islands close to Japan, they were able to initiate regular bombing raids on Japanese cities without the limits faced in the Doolittle Raid. The development of the B-29 bomber also facilitated bombing of Japan by allowing larger bombs to be carried from greater distances. In 1945 Colonel Curtis LeMay successfully experimented with a low-altitude fire bombing raid. Subsequently, most of Japan's large cities were subjected to intensive fire bombing.

Tokyo suffered about 100 air raids following its first bombing on April 18, 1942. Extensive areas of Tokyo were fire bombed in 1944 and 1945. The most destructive of these occurred on March 10, 1945 when an area of 40 km^2 was burned and approximately 84,000 people were killed (Nagasaki 1998).

The areas burned during the war included parks, shrines, temples, and cemeteries that supported a diverse population of trees, as well as extensive areas of housing, industrial facilities and transportation infrastructure. Many street trees, such as those lining Omotesando Avenue leading to the Meiji Shrine, and countless numbers of trees on private properties in the city were destroyed or damaged during the fire bombing. Estimation based on a 1941 street map (Jinbunsha 2004) of Tokyo showed there were 80 parks, 50 large private estates, 27 shrines/temples, 25 unidentified open spaces, 4 large Imperial properties, 4 cemeteries, 2 military grounds, and 1 nursery within the bombed area. The charred remains of many trees can be seen in photographs taken after fire bombings (Fig. 18.1, Ishikawa 1995).

The degree to which trees in Tokyo were destroyed depended upon their proximity to bomb detonation and to wooden structures that burned during the fire. Nagasaki (1998) identified 56 Second World War (WW II) relict sites in Tokyo. Thirty of these locations (23 are either temple or shrine grounds) have fire-scarred trees or stumps as a result of fire bombing. These trees were assumed to have survived the fire because of their tissue moisture content and absence of structures burning adjacent them. Such adjacent fires would have provided sustained heat necessary to dry leaf and wood tissue to the point that it would burn. Many of the species commonly planted in temple or shrine grounds, such as ginkgo (*Ginkgo biloba* L.), *Castanopsis cuspidata* (Thunb.) *Schottky*. var. *sieboldii* (Makino) Nakai, and camphor (*Cinnamomum camphora* (L) Sieb.), are fire resistant and capable of resprouting after fire.

Fig. 18.1 A view of Kaen-cho, Shinjuku-ku, Tokyo, on April 14, 1945 (Ishikawa 1995)

Street maps of Tokyo prepared prior to WW II do not indicate the presence of trees along streets and there are few detailed accounts of individual trees in the Tokyo area. However, based on landscaping contractors' historical contract records, it is estimated that about 63,000 street trees were lost during the war in the Tokyo area. Tokyo had 105,000 street trees in 1943; there were approximately 42,000 street trees reported in 1945 after the war. These street trees were further damaged or illegally cut in the following few years due to fuel shortage and in 1947 the number of street trees declined to 35,000. Some local residents also recalled that trees in parks and streets were cut to make coffins to bury the dead (Tokyoto Zoen Kensetsugyo Kyodoukumiai (Tokyo Landscape Construction Industry Co-operation) 1994).

In contrast to the extensive bombing of Tokyo, only the harbor area of Hiroshima was bombed prior to August 6, 1945, when the atomic bomb was dropped. A 4.5 ton uranium bomb was detonated at an altitude of 610 m near the center of the city at 8:15 AM. The shock wave of the detonation destroyed most structures within a 2.4 km radius of the point of detonation. The intense heat of the nuclear explosion created a fire storm that spread over a radius of 4 km. Based on the 1953 war damage survey report, 50 % of the trees within the 2 km zone had stems broken off by the blast; wind damage of trees beyond 2 km radius was not observed. However, trees that were not ripped from the ground or broken off were consumed by the fire. These included trees in parks, along the rivers and streets, as well as at temples and shrines. The impressive trees along the moat of the Hiroshima castle were among the trees that were destroyed.

As was the case in Tokyo, some areas of the vegetation within the parks were not entirely consumed by the firestorm. Hersey (1989) reports that some survivors of the shock wave took refuge in a grove of bamboo in Asano Park (a heavily vegetated privately owned large estate, now called Shukkei-en) to avoid the fire. Like trees at the edge of the forest at Meiji Shrine in Tokyo, the outer margins of the bamboo grove were scorched by fire, but fire did not penetrate into the interior of the grove.

Within the firestorm radius, street trees were destroyed. No maps recorded the distribution of street trees in Hiroshima prior to the bombing of the city. However, interviewees in Hiroshima indicated that weeping willows (*Salix babyloinca* L.) were commonly planted as street trees and along rivers. Photographs show the broken and burned remains of trees along some streets after the bombing. A 1953 atomic bomb damage report mentioned that the weeping willows near the old western parade ground (located southwest of Hiroshima Castle) were resprouting while other species planted among the weeping willows were not (Arboriculture Hiroshima (compiled by Horikuji) 2001).

The question of how many trees in Hiroshima were killed due to exposure to radiation released by the atomic bomb has never been answered. No systematic study of radiation caused tree mortality took place in Hiroshima or Nagasaki following the war. Trees nearest to the hypocenter were exposed to the highest levels of radiation as well as to the highest temperatures and strongest physical shock. In this core of death one cannot single out any one of these factors as the cause of tree mortality. The initial amount of radiation emanating immediately by the bomb's detonation that could potentially be absorbed by trees varied with their distance from the hypocenter. Radiation doses (free-in air gamma rays) ranged from 35 gy (3,500 rad) at 500 m, 3.9 gy (390 rad) at 1,000 m to 0.49 gy (49 rad) at 1,500 m from the detonated bomb (Radiation Effects Research Foundation 2006). The bomb was detonated at an altitude of approximately 610 m above the ground so that maximum initial radiation levels reaching any trees near the hypocenter would have been somewhat less than 3,000 rad. The average exposure of people who were not killed immediately by the detonation has been estimated to be between 220 and 250 rad (Morton and Solomon 1986; USDHHS 2003).

Experiments conducted on tree seedlings indicate the sensitivity to gamma radiation (measured in rad) varies with tree species as follows: pine, 600; fir, 730; hemlock, 750; spruce, 790; arborvitae, 1,700; poplar, 3,000; magnolia, 3,700; oak, 3,700; birch, 4,300; maple, 4,800; beech, 6,400; hickory, 6,400 (Sparrow et al. 1971). Whicker and Fraley (1974) explained the range of sensitivity of different plant species to radiation was a function of chromosome size. Plants with large chromosomes are relatively sensitive to ionizing radiation while plants with small chromosomes are less sensitive. The levels reported by Sparrow et al. (1971) that are necessary to damage tree seedlings are greater than the initial radiation dose at 1,000 m from the point of detonation. Experimental studies involving the release of gamma radiation in natural forests in the United States (Platt 1963) and observations of tree mortality following the Chernobyl accident in Ukraine (Sokolov et al. 1983) suggest that exposure to 3,000–6,000 rad is sufficient to cause mortality in mature pines trees while exposure to 10,000–20,000 rad is

required to kill mature hardwood trees. Hardwood trees exposed to the higher levels of radiation were observed to recover by sprouting in the year following exposure as long as exposure levels were below 50,000 rad. A case study of tree rings of one WW II surviving *Celtis sinensis* Pers. var. *japonica* (Planch.) Nakai in Hiroshima indicated that the impact of the atomic bomb on the reduction of tree growth lasted only 2 or 3 years (Shinada et al. 1985). It may be concluded from these studies that trees in Hiroshima did not initially receive radiations levels sufficient to kill them. The smaller branches of trees within slightly more than 500 m from the hypocenter could have been killed by the initial radiation level, as were the smaller branches of trees in the experiments in the United States and near the Chernobyl site. However, trees at this close distance to the point of detonation would surely have been killed by the shock wave and heat emanating from the detonation of the bomb. Surviving trees currently located within 500 m from the hypocenter in Hiroshima are either resprouts from the roots of trees damaged by the bombing or were transplanted to the site. It is believed that a few trees survived radiation exposure by being located next to tall brick/stone buildings or high walls that shielded them from radiation and initial blast. The *Ilex rotunda* Thunb. in Rai San-Yo Shiseki Museum's garden was behind a tall bank building and the ginkgo tree in Josaiji Temple was next to the brick wall of a factory when Hiroshima was bombed.

Additional radiation fell to the ground from the mushroom cloud created by the atomic bomb. Particulate matter dusted portions of the city while 'black rain' carried radioactive particles to the ground in some areas farther from the hypocenter. The dust and the black rain exposed many people who had survived the initial blast to levels of radiation that caused skin damage and subsequently various forms of cancer. No estimates of the radiation levels in the dust or 'black rain' are available and no information could be found as to the exposure of trees to this radiation.

Pre-war Planning

Prior to WW II, city planning in Japan was conducted by planning departments staffed by experts trained in city and regional planning, architecture, landscape architecture, and civil engineering. Planning efforts to modernize Tokyo began in late nineteenth century, while plans to modernize Hiroshima did not develop until the twentieth century. Comprehensive plans for Tokyo were adopted in 1884, while plans for Hiroshima were not adopted until 1925 (Hiroshima City 1985). These plans modernized the streets and infrastructure of older parts of the cities by straightening and widening streets and installing modern sewage and water systems. However, the plans proposed few measures to change the basic fabric of Tokyo or Hiroshima (Hein 2002, 2005). Natural disasters, such as the great Meireki fire of 1675 in Edo had destroyed large portions of Tokyo in the past. Planning responses to these disasters were primarily focused on systems of fire breaks and expansion of housing into adjacent undeveloped areas (Waley 1984).

Tokyo Pre-war Planning

In Tokyo the first parks were established after the Meiji Reform. Five parks (Asakusa, Ueno, Shiba, Fukagawa, and Asukayama) were created by the conversion of temples, shrines, or feudal lords' gardens under the Cabinet Decree (1873). Western style street trees were first planted about the same time (1873) in the Ginza District using native black pines (*Pinus thunbergii* Parl.) and cherry (*Prunus* sp.). Later in 1875 an introduced species (*Robinia pseudoacacia* L.) was used for streets along the outer moat on the eastside of the Imperial Palace. Weeping willow, cherry and black pine were popular species for street trees and along water courses.

Urban park planning for Tokyo started in 1885. City Block Reform (1888) planned to create 49 parks, about 333 ha total area, in Tokyo. This plan was not fully carried out, with only four small parks (1889–1891) and one big park, Hibiya Park (1903), being established. In 1902 a new City Block Reform plan was issued which reduced the number of parks from the previous plan to 22 parks (about 221 ha). A large urban forest (about 68 ha, 120,000 trees of 365 species) was designed and planted for the Meiji Shrine to commemorate Emperor Meiji who died in 1912. It included large areas of gardens, forests, and street trees. The design combined western and Japanese landscape style underscored with theories of forest ecology (such as succession). The construction lasted 11 years, from 1915 to 1926.

The importance of urban parks as open spaces was recognized during the 1923 Kanto earthquake. At that time Tokyo had 35 parks and open space areas. All but three of these were damaged by the earthquake. However, these parks and urban open spaces saved thousands of people's lives by providing fire breaks and sheltering up to 1.5 million refugees (about 70 % of the population of Tokyo then). The Capital Reconstruction Plan (1924) planned 3 large parks (Sumita, Kinshi, and Hamacho; about 20 ha) and 52 small parks (about 15 ha) for the earthquake damaged area. The Capital Reconstruction Plan also formally started the planting of western style street trees in Tokyo (Yoshinaga 1975). The street from Tokyo Train Station to the Imperial Palace (Gyoko Dori) was designed following examples of the Mall of Buckingham Palace in London and Paris's Champs Elysées. Four rows of ginkgo were planted on this 73-m wide road (Koshizawa 1991).

From 1932 to 1939, a city greenery plan was formed, which originated from the Europeans' regional planning movement in the 1920s. Tokyo's regional planning was the first in Japan, in which The Negotiation Committee for Tokyo Green Areas conducted surveys and policy studies. The plan covered a 50 km radius of Tokyo metropolitan area, 962,059 ha, and included a wide range of greenery concepts, from agriculture to scenic areas and later, as Japan was more engaged in war, to fire breaks and evacuation areas. Facilities being planned included large parks, green belts, natural parks, recreational parks, streets, and scenic areas (Koshizawa 1991).

After the Greenery Plan was finalized in 1939, the city government started purchasing land. In 1940, six large pieces of land (about 100 ha each) were purchased for large green areas in the then suburb, and up to 1945, 22 more pieces of land were purchased for green space. In the urban area after 1938, the city, using the Law of

Anti-Air Raid (1937–1946), started purchasing five pieces of land for parks, total 9.8 ha. Between 1940 and 1942, more than 20 urban parks were constructed (Koshizawa 1991). A 1941 Tokyo map showed there were at least 77 parks in the city of Tokyo (Jinbunsha 2004).

By the end of WW II Tokyo had 816.6 ha of land purchased for nine green belts and 30.7 ha of land was set-aside for 19 urban parks (Koshizawa 1991). The number of street trees reached 105,300 in 1944, more than ten times of the number after the earthquake in 1923 (10,262) (Cheng et al. 2000).

Hiroshima Pre-war Planning

In Hiroshima, under the Cabinet Decree (1873), two shrine sites were converted to parks in 1874 (one of them was removed in 1898) and in 1903 two more parks (on hills) were added. However, there were no comprehensive plans to develop these parks or to plan more parks until 1932, when Hiroshima hosted an economic promotion exposition. For the exposition one of the existing three parks (Hijiyama) received assistance from the central government and site improvements were made. The first planting of street trees by the city was in 1937 for a newly built 20-m wide street leading to the recently constructed Ujina Harbor. *Platanus* was planted. The first plan for urban parks in Hiroshima was written in 1941. The plan included 35 small parks, totaling 13.33 ha, and 4 green areas, totaling 62.02 ha. Since Japan was fully engaged in war, the planning of urban parks and green belts emphasized combating air raids. Site improvement and planting of trees started right after the plan was approved, but none of the parks or green areas was completed before the atomic bombing of the city in 1945.

In both Hiroshima and Tokyo these new parks sought to introduce amenities of lawn areas, flower beds, tennis courts, fountains, and other recreational facilities not common to traditional Japanese gardens (Yoshinaga 1975). The use of introduced species started to gain popularity, but exotic species were not widely used for parks and streets at that time. Supplies of large quantities of trees became necessary and commercialization of tree production began.

Post-war Planning

City planning was carried out on a military basis during the war. Army officers were in charge of urban planning activities as they affected the war effort. Many of the usual planning activities of the city planning departments were curtailed. Planning during war time involved improvement of the transport infrastructure of cities to serve the war effort, expansion of industrial facilities for the production of war materials, and the conversion and creation of city parks as staging areas for soldiers and equipment and for firebreaks. In some city parks, trees were cut down

to build barracks, to install anti-aircraft guns, and to marshal military equipment. Houses along streets or lanes were torn down to create fire breaks. In Hiroshima one such firebreak running in an east–west direction near the center of the city was straightened and converted into the present-day Peace Boulevard (Hiroshima City 1985). Many small parks and portions of larger parks were used for food production to support the civilian populations of cities. About 30 parks in Tokyo were used as temporary burial grounds for victims of the 1945 air raid. The city tree nurseries in Hiroshima were converted to community gardens to support the local population. City tree nurseries that supplied trees for streets and parks in Tokyo were not converted into community gardens because of their distance from the city. However, normal maintenance activities and the annual cycle of planting and the lifting of trees for planting in the city were suspended as manpower was needed for the war effort and urban forest expansion was put on hold.

The Japanese government started planning the restoration of cities as early as December 1945, when the 'Fundamental Guidelines for Postwar Recovery Planning' were issued. The recovery strategy was mainly based on land readjustment, acquiring land from private citizens for public open space and infrastructure.

Tokyo Post-war Planning

In Tokyo the 1946 plan intended to readjust 20,165 ha of land, build wide (more than 50-m wide) boulevards, set up green strips, secure 10 % urban lands for green areas, and set green belts in suburbs. This plan was severely set back by the economic measures proposed by the American banker/economist, Joseph M. Dodge, in 1949 to fight inflation and balance the government budget. This reduced the land readjustment area to 1,652 ha and eliminated all the plans for boulevards and urban green areas.

The idea of land adjustment was also not carried out because of the desire of private property owners to re-obtain control over their property. During the war the military government had exercised nearly complete control of private property. Once the war was over property owners were generally opposed to centralized control of rebuilding. In an attempt to nurture the democratization of city government in Tokyo, the American Army of Occupation under the leadership of General MacArthur curtailed any comprehensive planning that would infringe on the rights of private property owners. Sixty-two percent of the 746 ha of land purchased for green belt and four pieces of land purchased for urban parks were returned to private ownership.

Large urban parks were created as a result of the war as large parcels of land became available from the Imperial and military ownerships. The new Constitution transferred several Imperial properties to the public. Reconstruction of Shinjuku Gyoen (58.7 ha) and Kogyo Gaien as public parks started in 1948. Hamarikyu Onshi Teien (25 ha) was given to Tokyo Prefecture in November 1945 and later opened to the public in April 1946. Some of the areas that had been used by the Japanese

military in Tokyo were commandeered by the US military to house their own personnel and store equipment after the war. These sites became available later for public use when the US Army withdrew from Japan in 1952. When Tokyo was selected as a site for the 1964 Olympic Games in 1959, wide scale urban planning addressed again new tree-planting and the establishment of new parks. Yoyoki Park (the fourth largest park in central Tokyo) was a military parade ground prior to the war and was used to house US forces after the war. The Americans referred to the site as Washington Heights. It was changed to the Tokyo Olympic village and became a park after the Olympics. Shinku Gaien, the gardens surrounding Meiji Shrine, was also used as one of the venues of the Olympic Games.

Restoration of street trees in Tokyo was not fully launched until about 1948, when new supplies of trees became available from the city owned nurseries. In 1954 the number of street trees reached 80,300 and in 1959 the number reached 99,700. There were 112,637 trees in 1965, and 237,402 in 1980 (Cheng et al. 2000). Streets noted for their trees prior to the war were replanted after the war in an attempt to restore them to their pre-war condition. Notably among these is Omotesando Avenue where *Zelkova serrata* (Thunb.) Makino was restored through the efforts of Mr. Tokitaro Kasuga, a Tokyo landscape contractor. The *Zelkova* were initially planted around 1918 and 1919 while Meiji Shrine was being constructed. One hundred and fifty-one (92 %) of the pre-war population of 164 trees were severely damaged by American fire bombing. In 1948 Mr. Kasuga volunteered to replant the street trees along the Avenue. Trees of proper size (about 10 cm diameter) were not available nearby; he found his trees from northern Tama Hills, about 100 km west of Tokyo. In his first attempt only 4 % of the replanted trees survived due to unusual weather conditions (dry wind, high temperature) and shortage of labor. In a subsequent planting he was able to restore the entire street (Maeda 1996).

Streets in other parts of the city were initially replanted with trees growing in the city's tree nurseries at the end of the war. Many of these trees exceeded the size of trees usually planted (7–10 cm caliper) because nursery operations and city tree-planting had been suspended during the war. Trees in the nurseries grew to diameters often exceeding 20 cm during the war years (M. Maeda, 1996 personal communication). As no other trees were available these larger trees were planted with low survival rate. Mr. Munemasa Maeda, a retired landscape contractor who was employed immediately after the war to plant trees in Tokyo and interviewed in 2004, believes that all of the large trees transplanted into the city were replaced by the end of the 1950s (M. Maeda, 1996, personal communication).

From 1945 to 1981, members of the Tokyo Landscaping Contractors Association had contracts from the city to plant 127 parks in the burned area. The efforts of landscape contractors, like Kasuga Landscaping Company, dedicated to restoring certain avenues and the activities of Tokyo's departments of city planning and urban gardening, resulted in the replanting of many if not all of the street that formerly supported street trees.

The city parks and the Japanese army bases occupied by the US Army in Tokyo took on the appearance of American suburbs following the war. Construction of houses for Army officers and the planting of street trees at these sites was intended

to provide familiar housing areas for American servicemen and their families (Gilless, personal communication). Many landscaping contractors made it through the difficult time by doing landscaping work for the Americans and gained the practical experience of western style landscaping (Maeda, personal communication). When the US Army withdrew from Japan in 1952 the temporary housing was taken down and many of the American-planted street trees were transplanted to the new parks.

Due to the financial difficulties and rapid increase of the population in Tokyo, the urban greenery, along with other urban reconstruction plans, stagnated until 1959 when Tokyo was selected to host the 1964 Olympics. Ironically, many streets were widened and street trees were planted for this event (Koshizawa 1991), in spite of the earlier abandonment of the original reconstruction plan to build wide, tree-lined boulevards. Approximately 11,000 street trees were planted in 1962, about three times the amount of regular plantings (2,145 trees planted in 1956, 3,238 in 1957; 3,592 in 1958). This brought the street tree population back to the pre-fire bombed level (Cheng et al. 2000).

Hiroshima Post-war Planning

The post-war reconstruction of the urban forest in Hiroshima followed a different path. The wide scale destruction of the city, the loss of about 1/3 of the city's population, and the unique nature of the atomic bomb's destruction stimulated a more comprehensive approach to re-planning the city and creating new urban forests.

In 1946 a park restoration plan was proposed to establish three large (104 ha total) and 32 small (67 ha total) parks in Hiroshima. The three large parks were located at former military sites. This plan was not carried out because of budget limitations, the release of some of the lands intended for parks for agriculture due to food shortages after the war, and the need of new government buildings and other public facilities. The initial replanting of Hiroshima started with a reforestation project (using cherry and acacia) for Hijiyama Park in the southeast of the city to prevent erosion in 1948.

The current urban greenery plan was based on the 1949 Hiroshima Peace Memorial City Construction Law, which made crucial decisions concerning the urban forest. Included in the law were: (1) set aside 12.21 ha of land near the hypocenter, the center of Hiroshima, for a Peace Park to memorialize the people killed in the bombing and to make a statement against the use of nuclear weapons in the future; (2) set aside an area of 58.74 ha (later reduced to 44.1 ha), including the Hiroshima Castle for Chuo Koen (Central Park) to provide cultural and recreational facilities for citizens; (3) beautification and planting of green belts along river banks (7 rivers, 21.4 ha) and hills (6 areas, 376.2 ha) and (4) including the Peace Park, establish 7 large parks (165 ha) and 74 small parks (66 ha) throughout the city (Hiroshima Koen Gyokai (Hiroshima Park Association) 1978).

In 1950 the city sponsored a design competition for the Peace Park. The design competition also included a 100-m wide, tree-lined, major boulevard (Peace Boulevard), leading from the central business district to the Peace Park. The competition was won by Tange Kenzo Group, a Tokyo design firm. Street tree-plantings started in 1950 by using a particular species for a district, such as cherry (*Prunus yedoensis* Matsum) trees for Kyobashi-cho District, wingnut (*Pterocarya rhoifolia* Sieb. et Zucc.) for Shinsenba District, and sweet gum (*Liquidambar styraciflua* L.) for Ushita-cho District (Hiroshima Koen Gyokai (Hiroshima Park Association) 1978). By 1953, 3,619 single-strip street trees and 468 multiple-strip street trees, including Peace Boulevard, were planted.

The mayors of Hiroshima provided important leadership in the reconstruction of the city and its urban forests. They continued to push for a comprehensive redevelopment plan that at times was not fully supported by local residents, many of whom were unemployed and in need of housing. Public open spaces were occupied by tens of thousands of illegal squatters. The Peace Park site had 400 squatting households. The city not only spent considerable political capital in convincing landowners to exchange land for parks and the Peace Boulevard, but also initiated a successful urban greenery movement. In 1954 the then mayor, Shinzo Hamai, appealed to all mayors in Japan to donate trees to plant in Peace Park. As a result, flowers, seeds, seedlings, trees and money flowed into the city from all over Japan and overseas. Later in 1957, in order to get the needed quantity of large size trees for Peace Park, Central Park, and Peace Boulevard, the succeeding mayor, Tadao Watanabe, started a tree donation campaign focused on communities neighboring Hiroshima. More than 7,000 large size trees were donated from hills in the countryside and private gardens and thousands of citizens participated in the planting. These large trees were cut at 6-m height to facilitate transportation (Fig. 18.2, Hiroshima City 1985). By 1958, about 3,100 tall trees and many smaller trees were planted on Peace Boulevard. Due to the harsh site conditions and the size of trees, which were not optimal for transplanting, the survival rate was only about 55 % (Hiroshima Koen Gyokai (Hiroshima Park Association) 1978; Ishikawa, personal communication). But because of community involvement in the planting, awareness of urban greenery increased and Hiroshima was made a symbol of the anti-nuclear war movement both locally and internationally (Fig. 18.2).

Trees were brought into the city through the efforts of Mr. Ishikawa Tatsuo, an arborist who had worked in Hiroshima prior to the war and owned the only truck available after the war that could be used to bring trees to the city. He was given the responsibility of judging the potential success of trees offered to Hiroshima, the transportation of these trees, and their planting. Although the plans for the Peace Park and the Peace Boulevard prescribed certain species for planting based on the design concept and the aesthetic characteristics of the species, Mr. Ishikawa and his crew were only able to plant the species that were offered to the city. These trees were planted at the locations designated on the new plans, but seldom were the trees planted of the same species as the planting plans called for. Planting conditions were very bad during the initial planting period. The atomic bomb had created a rubble land of ash, charcoal, fractured

Fig. 18.2 Planting trees on Peace Avenue Greenbelt, November 27, 1957 (Hiroshima City 1985)

roof tiles, twisted steel, and broken concrete. No planting soil was available for back filling tree pits dug in the rubble. The city also had limited manpower for watering newly planted trees and water had to be hand carried initially from the nearby rivers. Many trees died and those that did survive were replaced later as trees of the species designated in the designs for the Peace Park and Peace Boulevard became available from re-instituted city nurseries.

As for the residual radiation of the atomic bomb in Hiroshima, surprisingly, it was not as threatening as expected. Even at the hypocenter, the radiation level declined to an unthreatening level within days. Plant and animal life were little affected. Some plants near the hypocenter resprouted within 2 months. Malformations of plants were observed, but the abnormalities ceased 3–4 years after the bombing. New colonies of various plants appeared in ruins in the next year after the bombing; 24 species were recorded in June 1946. Animal and insect populations at the hypocenter had fully recovered in October 1947 (Tsutsui 2004).

Surviving Trees

In both Tokyo and Hiroshima some individual trees survived the bombing. Many of these on private property were so disfigured by burning that they were removed to be replaced with new trees or to provide space for enlarged or new structures. Fire-damaged trees in shrines, temple gardens, and cemeteries were less likely to be cut down, although pruning of these trees for safety was often undertaken.

The city of Tokyo does not have a collective list of all of the surviving trees. Sightings of surviving trees are scattered among reports of individual tree-lovers and travelers (Nagasaki 1998; Yomiuri On-Line 2001, 2002). In 1998 Seizou Nagasaki published a book tracing the relicts of WW II in the city of Tokyo; among them are 42 trees in 30 locations and four standing stumps. The majority of the surviving trees are ginkgos (28), followed by *Castanopsis cuspidata* (Thunb.) *Schottky*. var. *sieboldii* (Makino) Nakai (4), camphor (2), *Platanus* sp. (2), *Aphananthe aspera* (Thunb.) Planch. (2), *Celtis sinensis* Pers. var. *japonica* (Planch.) Nakai (1), *Torreya nucifera* (L.) Sieb. et Zucc. (1), *Z. serrata* (Thunb.) Makino (1), and *Lagerstroemia indica* L. (1) (Nagasaki 1998). We located nine of these relicts and examined the trees in 2004. Figure 18.3 shows a surviving ginkgo tree at Asakusa Sensoji Temple in Tokyo.

Most of the trees examined were situated in temple gardens, shrines, and cemeteries. These were locations where the reconstruction of structures burned by the fire bombing was intended as architectural restoration rather than new construction that may have required tree removal. Some trees at these sites had spiritual significance prior to the war that contributed to their protection. These trees included a large (about 2 m dbh) ginkgo located at the Shiba Toshogu Shrine that is a designated National Natural Heritage tree and less well-known trees such as a 40 cm diameter ginkgo tree located at the Kandameishin Shrine. This tree is not listed in any national register, but it was not cut down for the expansion of a building on the site. Instead an alcove was placed in the building to accommodate the tree. Although some of the trees in Tokyo that survived World War II fire bombing have signs on or adjacent to them, none of these signs designate these trees as having survived the fire bombing. The signs usually indicate their old age or status on a national record.

The degree of fire damage to the trees varied considerably. Many trees had basal fire scars typical of what might be seen occurring in fire prone areas of natural forests. Others were significantly disfigured with fire charred trunks and major portions of their crowns missing. Some were only stumps. Their fire killed trunks and branches were removed after the war. These stumps exhibited varying degrees of sprouting. In one case a tall stump of gingko tree resulting from the fire bombing was not removed and is now covered with ivy at the corner of Kandameishin Shrine's entrance.

The trees that survived fire bombing in Tokyo were difficult to locate and often unknown as trees that had survived the war to the people responsible for their management. In our search for these trees we were assisted by four students from the

Fig. 18.3 One of the four ginkgo trees that survived the WWII fire bombing at Asakusa Sensoji Temple in Tokyo (May, 2004)

Laboratory of Landscape Ecology and Planning, Department of Ecosystem Studies of Tokyo University. They were invaluable in helping us to navigate Tokyo, a city in which few of the streets are named. None of these students were aware of the locations of any of these trees, nor of their existence. They had never been taken to see any of them as school children nor recalled any mention of them on the part of their teachers, youth leaders, or family members.

In Hiroshima about 150 surviving trees in 52 locations have been listed within the 2 km radius of the hypocenter (Hiroshima City 1985). Unlike Tokyo, Hiroshima started to collect information on surviving trees in 1974 after a group of elementary students tried to preserve a *Celtis sinensis* Pers. var. *japonica* (Planch.) Nakai tree in

their school yard. Each tree known to have survived the atomic bombing was marked by a sign attached to its trunk. The signs indicate the species of the trees, the distance the tree was from ground zero, and usually some comments about their condition after the bombing. A map showing the location of most of the trees is available at the Peace Museum.

We were able to collect information on 136 surviving trees in 50 locations; 22 of the locations are temples or shrines. The species composition is very diverse with 25 different species. Forty-five percent (61) of the trees are camphor which includes two large groves of 22 and 12 trees each. Others include *Ilex rotunda* Thunb. (11), ginkgo (8) *Pinus thunbergii* Parl. (8), cherry (*Prunus* × *yesoensis* cv. *Yedoensis*) (7), weeping willow (6), *Celtis sinensis* Pers. var. *japonica* (Planch.) Nakai (5) *A. aspera* (Thunb.) Planch. (5), *Platanus* sp. (4), *Wisteria* sp. (3), *Juniperus chinensis* Linn. cv. *pyramidalis* (3), *Firmiana simplex* (L.) W. Wight (2), and 1 tree each of *Camellia* sp., *Catalpa speciosa* (Warder ex Barney) Engelm., *Citrus natsudaidai* (Tanaka) Hayata, *Diospyros* sp., *Elaeagnus* sp., *Eucalyptus* sp., *L. indica* L., *Machilus thunbergii* Hayata, *Melia azedarach* L. var. *subtripinnata* Miq., tree peony (*Paeonia* sp.), *Prunus mume* Sieb. et Zucc., *Salix yezoalpina* Koidz. and *Tilia miqueliana* Maxim. Many of these trees were broken off at the base of their trunks by the initial blast of the bomb. They have resprouted and are somewhat difficult to recognize as formerly damaged trees. The weeping willow in Fig. 18.4 is a resprout whose above ground part was destroyed by the atomic bomb. This willow is located 370 m from the hypocenter and is the closest surviving tree to the hypocenter. Others exhibit extreme fire scars such as a willow (*Salix yezoaplina* Koidz.) tree in Hiroshima Castle, the trunk of which is a semicircle of wood no more than 6 cm thick. The extreme heat released by the detonation of the atomic bomb dried out the bark, cambium, and sapwood on the side of the tree facing the detonation. Fire then consumed the naturally drier heart wood until the burning reached the more moist sapwood on the opposite side of the tree. The top of this tree had been snapped off by the initial shock wave from the bomb's explosion. Sprouting took place at the broken top and the tree now resembles a semicircle supporting a live crown of new branches and foliage.

Trees that survived the atomic bombing in Hiroshima can be found in a variety of locations. Their sites are not limited to temple gardens, shrines, and parks, but include locations along the rivers and along streets, as well as on private land (NHK 2007). Some of the surviving trees located on private land were donated to the city and replanted in city parks to make them more accessible to the public or because the private land owners wanted to develop the property on which the trees occurred. It was evident that surviving trees were being looked after very carefully regardless of where they were located. People living in Hiroshima are aware of these trees. We asked young boys if they could tell us where a particular tree was located and they were able to direct us even though the tree might have been several blocks away.

Reverence for the surviving trees was evident in Hiroshima. The people who survived the atomic bomb were so overcome by the destruction of their city that they believed nothing would grow in Hiroshima for 75 years. However, within

Fig. 18.4 Located about 370 m from the hypocenter, the above ground part of this weeping willow was destroyed by the atomic bomb. The resprout has grown into a tree with 30 in. diameter at breast height (May, 2004)

weeks of the bombing, extensive areas of the city were covered with a growth of various herbaceous plants; even at a place near the hypocenter a circle of sickle-senna (*Senna tora* (L.) Roxb.) with extraordinary vigor was observed (Hersey 1989). Trees resprouted from injured trunks or their roots within 2 months (Hiroshima Peace Memorial Museum 1999; Tsutsui 2004). The ginkgo tree in Hosenbo Temple sent out new buds in September 1945. A new hope of survival spread through Hiroshima. The surviving trees of Hiroshima have been maintained as powerful symbols of both the destruction and survival of the city and its people (Tsuchida and Tredici 1993; Hiroshima Peace Memorial Museum 1999).

Discussion and Conclusions

Two different patterns of restoring urban forests following their destruction by war emerged in Tokyo and Hiroshima. Tokyo originally had a large-scale urban greenery plan but it was reduced to a much smaller plan, while Hiroshima expanded the original urban greenery plan and turned the city into a green city.

Tokyo followed a path taken by Oakland, California that rejected the opportunity to adopt comprehensive planning approaches that would have reshaped the burned portions of the city and its urban forests after the destructive fire in 1991 (Blonski and Morales 2002). Politicians in Oakland opted, under pressure from local residents whose houses had been destroyed, for returning to conditions prevailing prior to the fire. They were unable to embrace new planning proposals that called for significant changes in the structure and composition of parts of their city (Platt 1998). The fire insurance policies protecting most of the over 3,300 houses destroyed by the fire covered the cost of rebuilding the structures, but would not compensate home owners for abandoning their properties. Furthermore, the City of Oakland did not want to forego the loss of tax revenues from the high end residential neighborhoods that were destroyed in the fire. In Tokyo people wanted a return to conditions that existed prior to the war and they wanted little interference by public planners in the way they restored their private property. Hein (2005) points out a tradition of rapid rebuilding of homes and businesses in Tokyo following repeated natural disasters in the last 300 years. Private owners wanted to do just that after the war was over. There was no public support for significant change. The Governor of Tokyo was not enthusiastic about the plan prepared prior to the end of the war. City planners did not push for carrying out the plan, and with limited budget and lack of financial strategies, only 6.2 % of the area planned for restoration (1,274 ha out of 20,165 ha) was completed. The process of restoration of the urban forest in Tokyo began slowly after the war and did not result in much innovative planning until the 1964 Olympics. This follows a pattern for urban resilience described by Vale and Campanella (2005) as the Reconstruction II period. This period is characterized by major construction that often replaces post-disaster construction to return a city to its pre-disaster functions of housing and transportation. The initiation of work on a new Civic Center complex that started 6 years after the 1906 San Francisco earthquake is cited by Vale and Campanella (2005) as an example of Reconstruction II period resilience. Development of a new Civic Center complex along with new housing developments associated with the Panama Pacific Exposition, like the work in Tokyo for the 1964 Olympics, made important contributions to the San Francisco urban forest.

In contrast, Hiroshima rebuilt itself with considerable innovation in design and community involvement of its streets, parks, and waterways. These new plans called for the planting of many trees in places not previously supporting trees. Design competitions provided plans for new parks, boulevards, and the incorporation of more trees into the city. Proactive leadership was exhibited by Kenzo Tange, whose firm won the design competition for the Peace Center, and

the mayors in Hiroshima. The city planning department avoided the interests on the part of many private landowners to rebuild the city as it had been before the bombing. This effort was aided by the unique nature of the atomic bomb that destroyed such a large portion of the city's population and left little of the city's former architecture, infrastructure, or urban forest.

There is a strong human tendency to want to return to the conditions of one's past environment (Cooper-Marcus 1995). This tendency has been demonstrated in public resistance to post-disaster city planning throughout history (Vale and Campanella 2005). Several factors contributing to this desire to reconstruct the pre-disaster environment include a need to reconstruct the social fabric, the power of property rights, and construction costs that may be substantially reduced if building can take place on existing foundations. A portion of this desire to return to one's past environment also includes a desire for lost trees. This can be seen in the individual efforts of men like Mr. Ishikawa Tatsuo in Hiroshima and Mr. Takitaro Kasuga in Tokyo. Similar personal efforts in the replanting of war-damaged trees have been reported in European cities following World War II (Akers, personal communication; Ivanovna, personal communication; Schroder, personal communication; von Ehren, personal communication). This also demonstrates that the quality of the pre-disaster urban forest is very important. It determines the possibility of its restoration after disaster. It may take events of immense destruction, like the atomic bombing of Hiroshima, to jar citizens and planners into thinking about new ways to rebuild destroyed cities and their urban forests. Hiroshima's reconstruction was fostered by its symbolic meaning as a 'rallying point for Japanese aspirations for nation-building' (Orr 2001) and international support for its meaningful Peace Park (Hein 2002). Innovative political leadership was also an important ingredient of the successful planning and redevelopment of Hiroshima and will be required in the future to promote new directions in the rebuilding of cities devastated by both natural and man-made destruction. In conclusion, the differences between Tokyo and Hiroshima on the urban forests reconstruction after the war are summarized in Table 18.1.

There is a growing literature on the rebuilding of cities following natural and man-made destruction; several examples have been mentioned in this article. In contrast to the treatment of urban forest in this volume, the main focus of these and other publications has been on architecture and urban planning, with little or no attention to the urban forest. Different scenarios for urban reconstruction fall into two major categories. These are (1) a return to the past or (2) rebuilding along new designs that use the disaster as an opportunity for innovation (Gunderson 2010). Both scenarios have led to a rebirth of urban forests. The rebuilding of Tokyo followed the first category until plans for the 1964 Olympics were adopted. Until that time the reconstruction of the urban forest was primarily limited to tree replacement. Similar patterns are to be seen in the reconstruction of London (Akers, personal communication), Stalingrad (Spebenna, personal communication), Hamburg (von Ehren, personal communication), and portions of Berlin (Ladd 2005, but see also Cramer, Chap. 34, this volume). Hiroshima reconstruction falls into the second category that is characterized by more far reaching, and innovative planning. The new planning directions in Hiroshima expanded and enriched urban tree-planting.

Table 18.1 Comparison of Tokyo and Hiroshima's war damage and urban forest recovery

Characteristics	Tokyo	Hiroshima
Area destroyed	15,867 ha[a]	1,200 ha[b]
Number of people killed	148,279 (Dec. 1944–Aug. 1945)	80,000–140,000
Financial restriction on reconstruction	Severe	Severe
Number of parks before war in war-damaged area	1941: 80 large and small parks (about 202 ha)[d]	1941: 35 small parks (total 13.33 ha) and 4 green space areas (62.02 ha) planned, not completed
Number of street trees before war	1943: 105,000	Unknown
Initial plan after war	20,165 ha for block readjustment; build 7 (100-m), 2 (80-m) wide boulevards with green strips, other radial, and loop roads; secure 10 % of urban areas for green space; establish green belts around the city	1,322.5 ha for block readjustment; build 24 roads (two 100-m wide roads), 3 large parks (104 ha total), 32 small parks (67 ha total), 4 green areas; secure 10 % of urban areas for greeneries
Source of land	Military, imperial, land exchange	Mostly military, small amount land exchange
Changes in the initial plan after the war	1947: 9,918 ha for block adjustment; 1950: 4,958 ha for block adjustment; a network of 25-m wide roads	1952: One 100-m road, 7 large (165 ha total), 74 small (66 ha total) parks, 7 green belts along rivers (21.4 ha total) and 6 green belts on hills (3,762 ha total); among these are the Peace Park (12.21 ha) and Chuo Park (44.1 ha)
Post war street trees	1953: 76,600 1963: 108,717	1953: 3,619 plus 468 trees on Peace Boulevard. 1958: 1,300 large trees on Peace Boulevard. 1970: 4,445 (not including Peace Boulevard)
Public involvement	1948: Mr. Tokitaro Kasuga voluntarily donated and planted 151 trees along Omotesando Ave	1954–1956: plants and money donated from Japan and overseas for the planting of Peace Park. 1957–1958: about 7,000 trees donated from neighboring counties
Surviving trees	42 in 30 locations (23 are shrine/temple); 9 different species	136 in 50 different locations (22 are shrine/temple); 25 different species

[a]From March to May 1945 (Koshizawa 1991)
[b]Hiroshima City 1985
[c]The United States strategic bombing survey, summary report (Pacific War 1946)
[d]Estimated from 1941 Tokyo map (Jinbunsha 2004)

Similar patterns of rebuilding and redesigning portions of urban forests can be seen in the post-disaster reconstruction of Lisbon (Maxwell 2002), Chicago (Miller 2002), Dresden (Schroder, personal communication), and portions of Berlin (Ladd 2005).

In both cases, the lack of proper size trees for large-scale replanting after the disaster of war was a common problem. Forested areas surrounding both Tokyo and Hiroshima provided sources of trees for planting. The demand for labor for tree-planting and post-planting care such as watering posed another challenge. Community participation, both within and outside the city, is a useful tool for urban forest recovery as we learned from Hiroshima (see also Tidball, Chap. 20, this volume).

We found that the species and locations of urban trees determine the survival of trees after disaster or war. In both Tokyo and Hiroshima, species with thick bark and strong resprouting ability survived the war. In Tokyo, trees in open ground had a better chance to be spared from fire, while in Hiroshima, trees behind tall concrete constructions were shielded from radiation and the heat wave.

Like most cities around the world (Vale and Campanella 2005), both Tokyo and Hiroshima's urban reconstruction and urban forest recovery were restrained by land ownership. The creation of large urban parks in Tokyo and Hiroshima was only possible because of the transfer of military and Imperial owned lands. With increasing individual power of property rights, high price of urban real estate, and the fragmentation of urban land ownership, it is difficult to allocate lands for new urban parks or forests. Politicians, policy makers, urban planners, developers, and insurance industries may need to get together and develop strategies to enable and encourage greening in the red zone by providing incentives for post-disaster urban open space or urban forestry development.

Acknowledgments The authors would like to thank Prof. Fujio Hirata of the Awaji Landscape Planning and Horticulture Academy and Mr. Keizo Fukunari for their assistance on arranging interviews and field guides. We also want to thank Mr. Takao Kobayashi and Mr. Yutake Shinohara of the Hiroshima City, City Planning Bureau, Green Promotion Department for providing city records. Our deepest appreciation goes to Mr. Munemasa Maeda, Mr. Tatsuo Ishikawa, and Mr. Satoyoshi Nishiyama who provided us first-hand experience after the war. Without Kenya Ukawa, Hiromitsu Tomidokoro, Koyanagi Tomoyo, and Tomoko Uetake, we would not have been able to see so many burnt trees surviving in Tokyo's high-rises. This study was funded by the Awaji Landscape Planning and Horticultural Academy, Hyogo Prefecture, Japan and the Farrand Fund for Landscape Architecture Research, University of California, Berkeley, CA.

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