Chapter 1
The Ooyamazawa Riparian Forest: Introduction and Overview

Hitoshi Sakio

Abstract Long-term ecological research (LTER) began at the Ooyamazawa riparian forest research site in 1983. Ooyamazawa comprises a representative cool-temperate zone old-growth riparian forest that is species-rich and contains complex topography. The Ooyamazawa river basin comprises at least 230 species of vascular plants, including 46 woody tree species that are found within the research site. Researchers have used this site to study forest structure and tree life histories over a 35-year period. In particular, research has focused on the life histories of the dominant canopy species *Fraxinus platypoda*, *Pterocarya rhoifolia*, and *Cercidiphyllum japonicum*. After the research site was registered as a Core Site of the Monitoring Sites 1000 Project, research began on avifauna and ground beetles, in addition to ongoing forest research.

Keywords Climate characteristics · Historical research site · Long-term ecological research · Natural disturbance · Old-growth forest · Ooyamazawa riparian forest · Riparian vegetation · Study design · Topography

1.1 Introduction

The Ooyamazawa riparian forest is a representative riparian forest in a cool-temperate zone in Japan. Many researchers have visited the forest to conduct studies, and numerous papers (Sakio 1993, 1997; Sakio et al. 2002, 2013; Kubo et al. 2000, 2001a, b, 2005, 2008, 2010; Kawanishi et al. 2004, 2006; Sato et al. 2006) and books (Sakio and Tamura 2008; Sakio 2017) have been published. This research site attracts attention not only as a riparian forest in Japan but also due to its status as a long-term ecological research (LTER) site. Ecological research at the site began in 1983 and has been ongoing ever since. During this period, substantial data on tree

H. Sakio (✉)
Sado Island Center for Ecological Sustainability, Niigata University, Niigata, Japan
e-mail: sakio@agr.niigata-u.ac.jp; sakiohit@gmail.com

H. Sakio (ed.), *Long-Term Ecosystem Changes in Riparian Forests*, Ecological Research Monographs, https://doi.org/10.1007/978-981-15-3009-8_1

life histories and coexistence have accumulated. Major changes have occurred in the forest; for example, forest floor vegetation has decreased dramatically as deer populations have increased. The reproductive characteristics of trees have also shown long-term changes, possibly due to global warming.

1.2 History of Long-Term Research in the Ooyamazawa Riparian Forest

The Ooyamazawa riparian forest is part of the forest land owned by Saitama Prefecture. It is located in Ooyamazawa, Nakatsugawa, Chichibu, Saitama, Japan (Fig. 1.1). The forest was donated to Saitama Prefecture in 1930 by Seiroku Honda, PhD. The Saitama Prefecture forest is made up of 12 forest stands, including old-growth forest, coppice forest, and plantations of *Cryptomeria japonica* and *Chamaecyparis obtusa*. Ooyamazawa comprises the 106th and 107th forest stands.

Wood production by selective cutting of old-growth forest was conducted in the downstream part of Ooyamazawa from 1936 to 1941, and there are no logging records prior to 1936. Timbers were transported downstream by water discharged from a log dam known as a "*Teppou zeki*" (Fig. 1.2). At that time, the upper basin of Ooyamazawa had not been cut down and the natural forest was conserved.

Construction of a forest road along the Ooyamazawa stream began in 1964 through this forest stand (Fig. 1.3). However, public opposition to the felling of the national forest of the Chichibu Mountains increased, such that construction of the forest road was stopped mid-way through 1969. Most of the natural riparian forests in mountain regions in Japan have been lost to clear cutting, and were replaced by conifer plantations after World War II; thus, there are few natural riparian forests left. The upper part of the Ooyamazawa riparian forest is valuable because it has not been affected by human activities such as logging or erosion control works.

In 1950, this area was designated as a Class II special zone (i.e., an area in which agriculture, forestry, and fishery activities must be coordinated to suit the environment) of Chichibu-Tama National Park. In 2000, the area was renamed Chichibu-Tama-Kai National Park.

In 2013, a portion of these stands (109.12 ha), including the riparian zone (5 ha), was designated as a Natural Monument of Saitama Prefecture. This area was designated as the Kobushi Biosphere Reserve in 2019.

In October 1983, a riparian area research plot (core plot: 60 m × 90 m) was demarcated, and was subsequently extended to 4.71 ha along the mountain stream from 1991 to 1998. In December 2006, the research site was registered as an associate site of the Japan LTER Network (JaLTER; http://www.jalter.org/en/researchsites/). In 2008, a 1-ha plot, including a 0.54-ha core plot in the research site (Fig. 1.4), was also registered as a Core Site of the Monitoring Sites 1000 Project by the Ministry of the Environment, Japan (http://www.biodic.go.jp/moni1000/index.html).

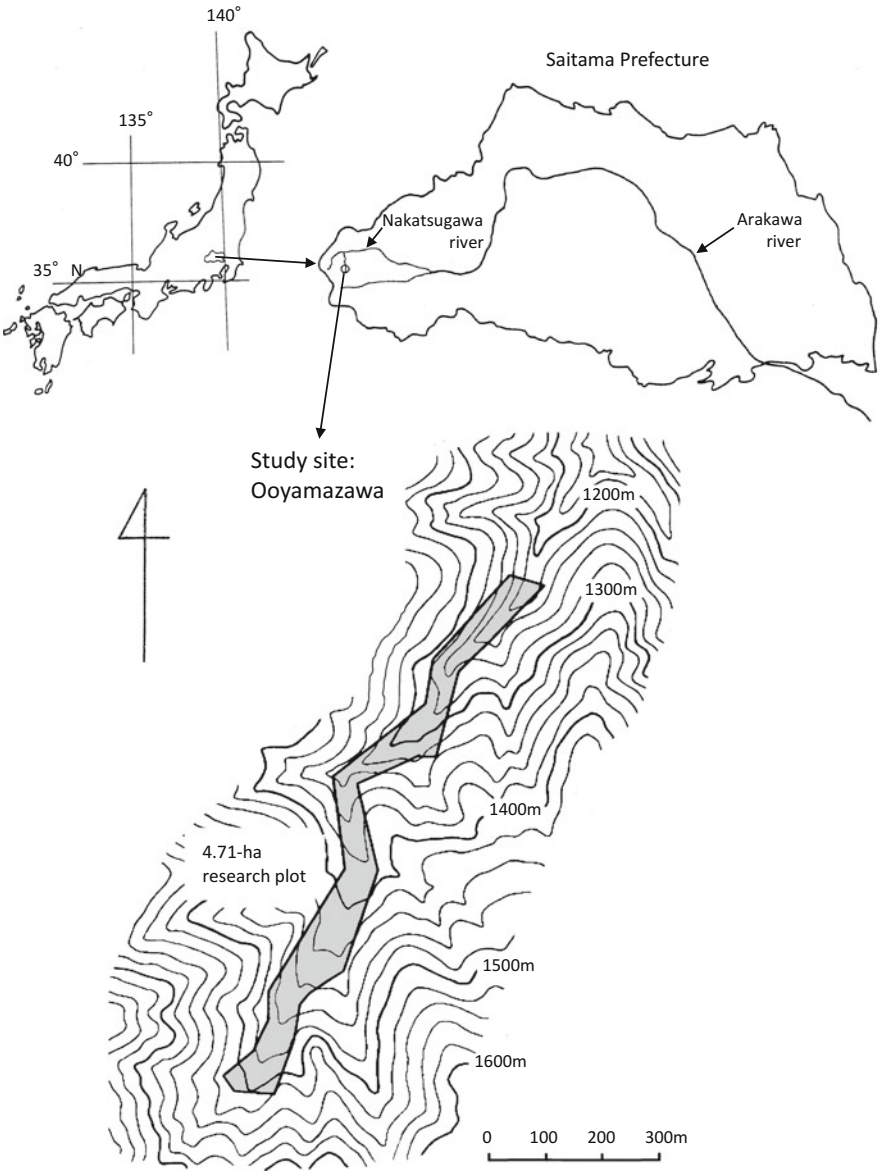

Fig. 1.1 Map of the experimental area within the research site

1.3 Site Description

The Ooyamazawa riparian forest research site (35°57′48″ N, 138°45′22″ E) is located in the Chichibu Mountains of the Kanto region of central Japan (Fig. 1.1). This site is located in a riparian zone along a small stream (Ooyamazawa) of the

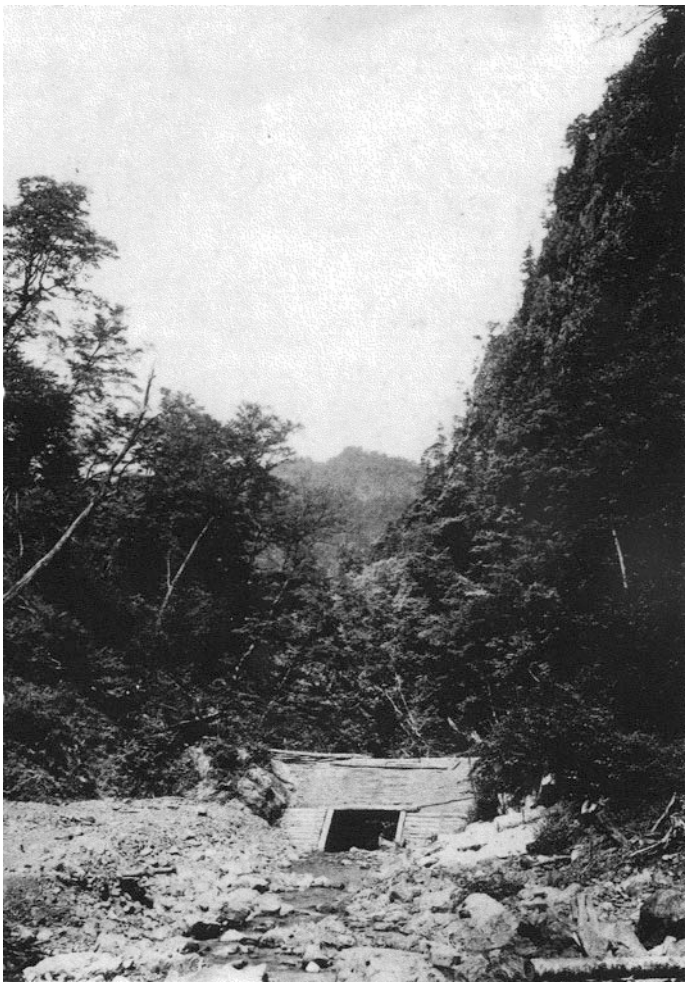

Fig. 1.2 A log dam, known as a *Teppou zeki*, in the Ooyamazawa stream. Photograph courtesy of Saitama Prefecture

Nakatsugawa River branch of the Arakawa River in Saitama Prefecture, central Japan. The site is situated within the Chichibu-Tama-Kai National Park and ranges from 1210 to 1530 m above sea level (a.s.l.). The 106th and 107th forest stands in Ooyamazawa cover approximately 512 ha.

Fig. 1.3 The entrance of a forest road along the Ooyamazawa stream

1.4 Climate Characteristics in the Ooyamazawa Riparian Forest

There is a large difference in climate between the Pacific Ocean and Japan Sea sides. On the Japan Sea side, snow and rain are abundant in the winter due to seasonal northwest winds. On the Pacific side, a significant amount of rain falls during the summer due to southeast seasonal winds blowing from the Pacific Ocean. The Ooyamazawa research site is on the Pacific Ocean side. Japanese forest zones are divided into four categories: subarctic forest, cool-temperate forest, warm temperate forest, and subtropical forest; Ooyamazawa is a cool-temperate forest.

1.4.1 Air Temperature

The mean annual temperature at the study site (1450 m a.s.l.) is 7.1 °C. The mean air temperature is 18.3 °C in the warmest month (August) and −5.2 °C in the coldest month (January) (Fig. 1.5). The monthly average maximum temperature is 20.3 °C in August and the monthly average minimum temperature is −8.6 °C in January

Fig. 1.4 Core Site of the Monitoring Sites 1000 Project, as designated by the Ministry of the Environment, in the Ooyamazawa riparian forest

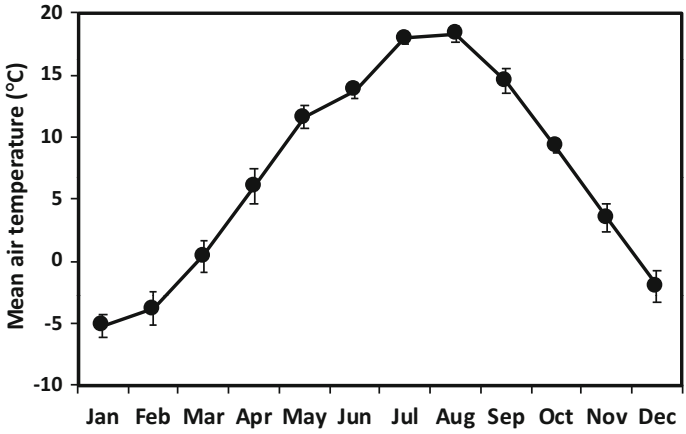

Fig. 1.5 Monthly mean air temperatures in the Ooyamazawa research site from 2008 to 2018

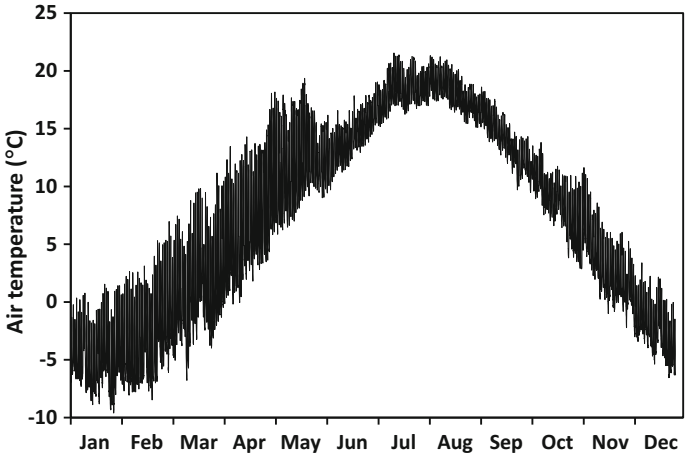

Fig. 1.6 Diurnal ranges of air temperature in the Ooyamazawa research site from 2008 to 2018

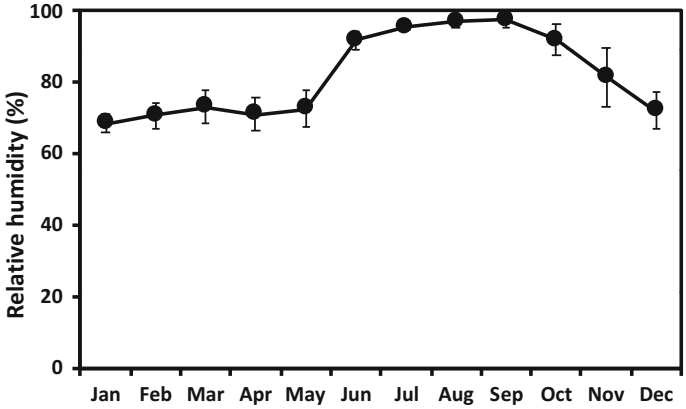

Fig. 1.7 Monthly mean relative air humidity in the Ooyamazawa research site from 2014 to 2018

(2008–2018). The diurnal ranges of air temperature from January to May are larger than in other months due to the development of canopy leaves (Fig. 1.6).

1.4.2 Relative Air Humidity

The mean annual air humidity was 81.9% from 2014 to 2018. The maximum mean air humidity was 97.4% in September and the minimum was 68.3% in January (Fig. 1.7). The air humidity is higher in the summer season than in the winter season. The diurnal ranges of air humidity were larger from January to May than in other months (Fig. 1.8).

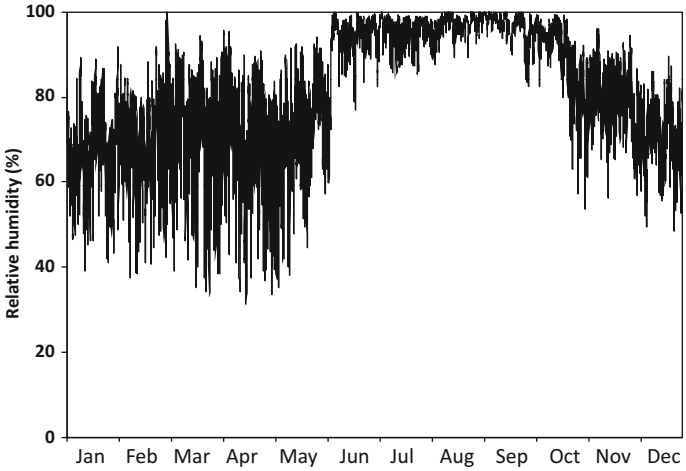

Fig. 1.8 Diurnal ranges of relative air humidity in the Ooyamazawa research site from 2014 to 2018

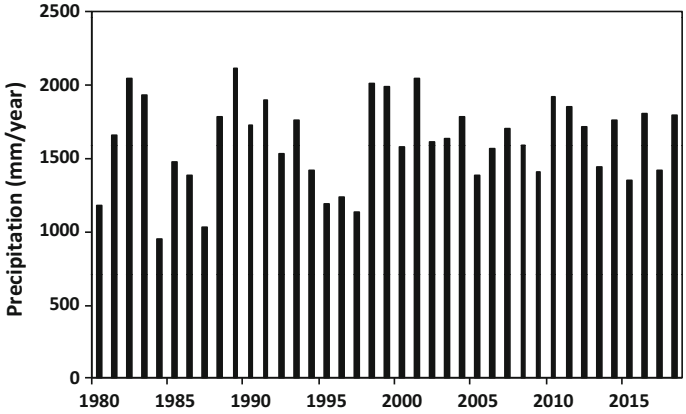

Fig. 1.9 Changes in precipitation measured at the Mitsumine automated weather station in Saitama Prefecture from 1980 to 2018. This station is 975 m above sea level (a.s.l.) and 15 km from the Ooyamazawa research site

1.4.3 Precipitation

The mean annual precipitation at the Mitsumine automated weather station in Saitama Prefecture, located 15 km from the research site at 975 m a.s.l., was 1611.7 mm from 1980 to 2018 (Fig. 1.9). Precipitation is higher in summer than in winter due to the rainy season and the occurrence of typhoons (Fig. 1.10). In particular, due to a large typhoon, 717.5 mm of precipitation was recorded in August 2016. On 14 August 1999, we recorded 440 mm of daily precipitation. The mean

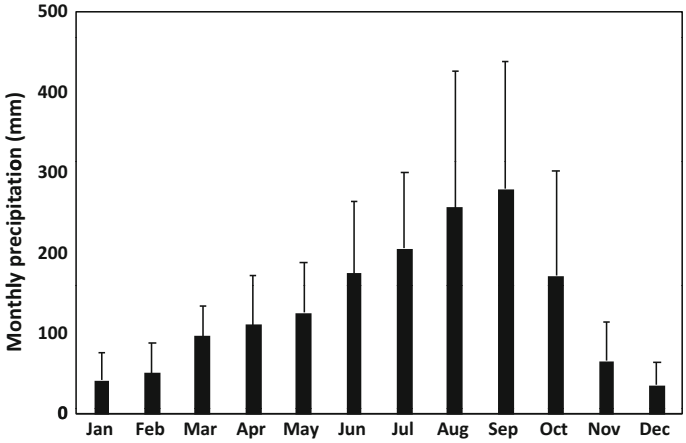

Fig. 1.10 Monthly mean precipitation at the Mitsumine automated weather station in Saitama Prefecture from 1980 to 2018

maximum snow depth at the research site was approximately 30 cm between January and March. However, in 2014, there were heavy snowfalls and the snow depth was estimated to exceed 3 m in the valley bottom due to avalanches.

1.5 Geology, Topography, Natural Disturbances, and Soils

The study area is covered by graywacke and sandstone of the Paleozoic era. The Chichibu Mountains have a complex topography with steep slopes (greater than 30°) and a network of mountain streams. This area is registered as a Japanese Geopark.

The topography of the Ooyamazawa riparian research plot along the stream (1.2 km) can be divided into two parts: the downstream area is a V-shaped valley with a steep slope of 30° (Fig. 1.11), and the upstream area is a wide floodplain characterized by debris flows and landslides with a slope of 12° (Fig. 1.12).

In the Chichibu Mountains, large typhoons accompanied by >300 mm of diurnal precipitation have occurred once every decade throughout the twentieth century (Saitama Prefecture & Kumagaya Local Meteorological Observatory 1970). These heavy rains result in debris flows (Fig. 1.13), surface landslides, and channel movements that do not improve light conditions on the mountains, whereas another type of disturbance, involving the destruction of large areas of canopy trees, improves light conditions. For example, large earthquakes and typhoons can cause large mass movements through landslides (Fig. 1.14). Sedimentation and erosion of

Fig. 1.11 The V-shaped valley in the downstream area. The hillside is very steep with a slope of >30°

sand and gravel occur on a small-scale every year in the active channels during the rainy and typhoon seasons. Flooding during these times has resulted in the emergence of abandoned channels and large deposits (Sakio 1997).

A typical soil for this area is a moderately moist brown forest soil (BD). However, riparian zones have complex microtopography with many soil types. The substratum of the active channel is sand and/or gravel, while that of the hillslope is mature soil. In the active channel, the ground surface is covered with large rocks, gravel, and sand. In the winter season, only groundwater flow is present. In the abandoned channel, no movement of sand or gravel occurs due to stream flow and there is a dense *Fraxinus platypoda* and *Pterocarya rhoifolia* sapling bank. In the floodplain, there are two A horizon layers containing plant roots due to repeated sedimentation. Meanwhile, on the hillslope, a thick litter layer and a humus layer can be observed in the soil profile (Sakio 1997; Fig. 1.15).

Fig. 1.12 The wide floodplain characterized by debris flows and landslides in the upstream area

1.6 Vegetation

The Ooyamazawa riparian forest (4.71 ha) is a species-rich natural forest. This forest is situated in the upper areas of a cool-temperate, deciduous broad-leaved forest zone that ranges from 700 to 1600 m a.s.l; it is a typical mountain region riparian forest classified as a *Dryopterido—Fraxinetum commemoralis* type (Maeda and Yoshioka 1952) originally reported by Suzuki (1949). However, Ohno (2008) suggested that it should be classified as *Cacalio yatabei—Pterocaryetum rhoifoliae*, as per the riparian forest communities in the mountain belts of the inland Chubu and Kanto regions.

The Ooyamazawa river basin contains at least 230 species of vascular plants (Kawanishi et al. 2006). Forty-six woody tree species were reported in a 4.71-ha research plot (Sakio 2008); of these, nineteen were canopy tree species. Canopy layer species are over 30 m in height and include *F. platypoda*, *P. rhoifolia*, and *Cercidiphyllum japonicum*. The dominant plants in the subcanopy layer are *Acer shirasawanum* and *Acer pictum*, while the lower layer is dominated by *Acer carpinifolium* and *Acer argutum*. The main herbaceous species in the understory are *Mitella pauciflora*, *Asarum caulescens*, *Meehania urticifolia*, and *Dryopteris polylepis*.

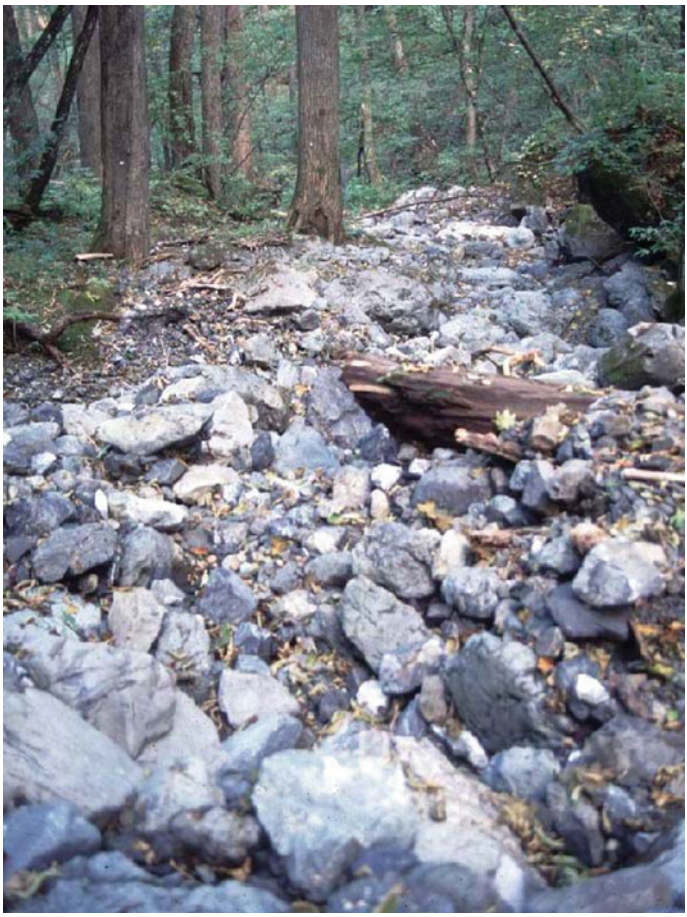

Fig. 1.13 Debris flow after heavy rain (Sakio 2008)

1.7 History of the Ground Design of the Research Plot

We demarcated a permanent plot of 60 × 90 m (0.54 ha), in the Ooyamazawa riparian forest in October 1983 (Fig. 1.16), and researched the forest structure and soil profile (Sakio 1997). This plot was extended to 4.71 ha along the mountain stream from 1991 to 1998. The plot was long (1170 m) and narrow (30–60 m), and comprised 30 × 30-m subplots that covered the lower part of a hillside adjacent to the riparian area (Sakio et al. 2002).

Fig. 1.14 A deep-seated landslide after a typhoon, which caused large mass movements and changes in light conditions

All living trees ≥4 cm diameter at breast height (DBH) were numbered and identified to the species level, and divided into canopy trees, subcanopy trees (DBH ≥ 10 cm), and small young trees (DBH < 10 cm). Canopy trees reached the top stratum of the forest. All trees were mapped using a compass survey.

Seed and leaf production have been measured from 1987 to the present. We set 20 conical litter traps approximately 1 m above the ground in a regular pattern within the core plot (0.54 ha) in May 1987 (Fig. 1.17). Litter traps were made of nylon netting (~1.0-mm mesh) with 0.5 m radius openings. When the plot became a Monitoring Sites 1000 Project Core Site (1 ha, including the 0.54 ha core plot) in April 2008, we added five new litter traps, giving 25 traps in total (Fig. 1.17). The litter trap size was changed to a 0.4-m radius in 2010. We collected the contents of the litter traps and brought them back to the laboratory every month between May and November. In the winter, the traps were left in the plot. In the laboratory, we divided the litter into seeds, flowers, fruits, fallen leaves, and branches/bark, measured the weight of each litter type and counted the seeds. From 1987 to 1994,

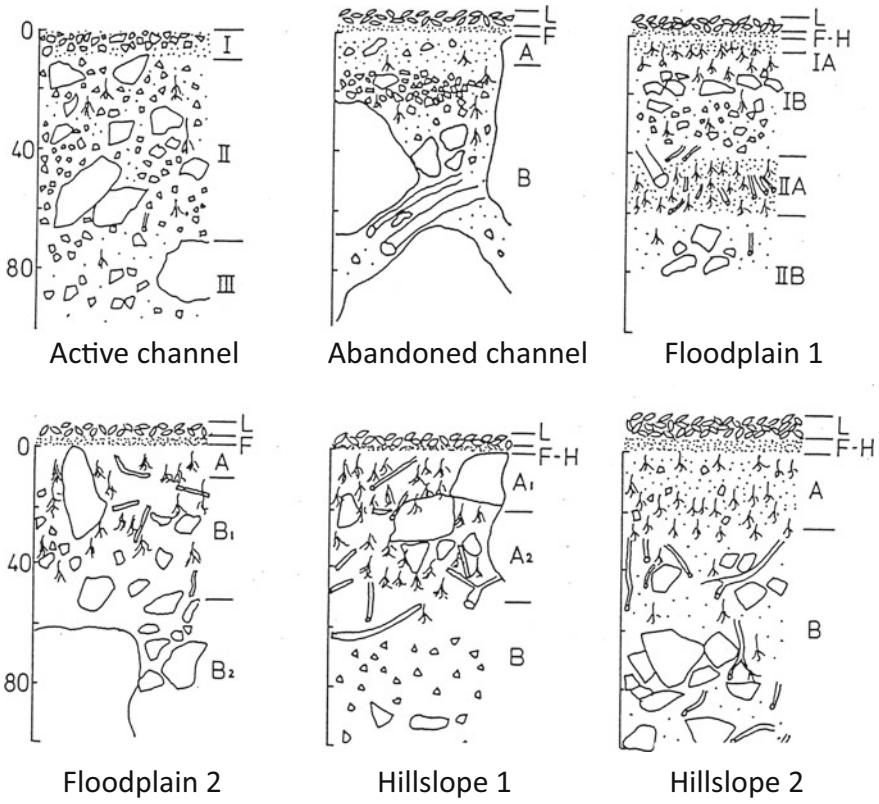

Fig. 1.15 Soil profiles at the core plot in the Ooyamazawa research site (Sakio 1997). The soil of the active channel was immature and divided into three layers. Floodplain 1 showed two A horizons due to repeated sedimentation

only *F. platypoda* was measured; after 1995, *F. platypoda*, *P. rhoifolia*, *C. japonicum*, *Tilia japonica*, *Ulmus laciniata*, *Carpinus cordata*, *Abies homolepis*, and some *Acer* species were also measured.

Studies of ground beetles have been in progress at the Monitoring Sites 1000 Project Core Site since 2008. Five subplots (5 m × 5 m) have been established within the Core Site and four pitfall traps were installed in each subplot. In addition, a bird survey project conducted at five fixed points in Ooyamazawa was established in 2010.

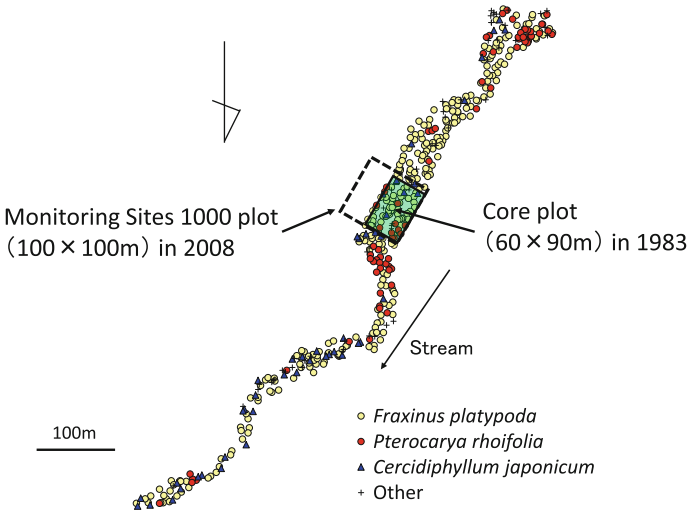

Fig. 1.16 History of the study design of the Ooyamazawa research site. The core plot (60 m × 90 m) was demarcated in 1983. The research site was extended to 4.71 ha along the mountain stream from 1991 to 1998. The core plot was extended to a 1-ha plot and registered as a Core Site of the Monitoring Sites 1000 Project in 2008

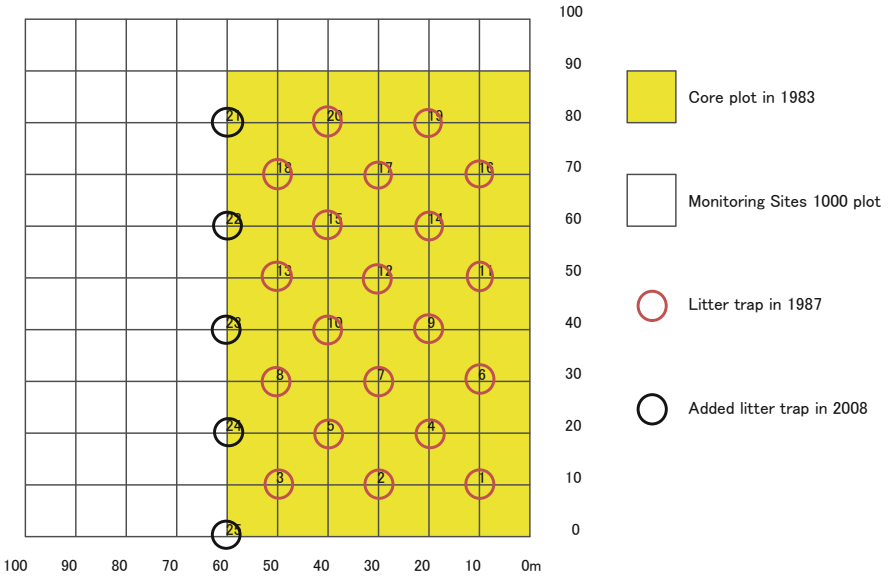

Fig. 1.17 Layout of litter traps in the Monitoring Sites 1000 Project Core Site

References

Kawanishi M, Sakio H, Ohno K (2004) Forest floor vegetation of *Fraxinus platypoda - Pterocarya rhoifolia* forest along Ooyamazawa valley in Chichibu, Kanto District, Japan, with a special reference to ground disturbance. J Veg Sci 21(1):15–26 (in Japanese with English summary)

Kawanishi M, Sakio H, Kubo M, Shimano K, Ohno K (2006) Effect of micro-landforms on forest vegetation differentiation and life-form diversity in the Chichibu Mountains, Kanto District, Japan. J Veg Sci 23:13–24

Kubo M, Shimano K, Sakio H, Ohno K (2000) Germination sites and establishment conditions of *Cercidiphyllum japonicum* seedlings in the riparian forest. J Jpn For Soc 82:349–354 (in Japanese with English summary)

Kubo M, Shimano K, Sakio H, Ohno K (2001a) Sprout trait of *Cercidiphyllum japonicum* based on the relationship between topographies and sprout structure. J Jpn For Soc 83(4):271–278 (in Japanese with English summary)

Kubo M, Shimano K, Ohno K, Sakio H (2001b) Relationship between habitat of dominant trees and vegetation units in Chichibu Ohyamasawa riparian forest. Veg Sci 18(2):75–85 (in Japanese with English summary)

Kubo M, Sakio H, Shimano K, Ohno K (2005) Age structure and dynamics of *Cercidiphyllum japonicum* sprouts based on growth ring analysis. Forest Ecol Manag 213:253–260

Kubo M, Kawanishi M, Shimano K, Sakio H, Ohno K (2008) The species composition of soil seed banks in the Ooyamazawa riparian forest, in the Chichibu Mountains, central Japan. J Jpn For Soc 90(2):121–124 (in Japanese with English summary)

Kubo M, Shimano K, Sakio H, Isagi Y, Ohno K (2010) Difference between sprouting traits of *Cercidiphyllum japonicum* and *C. magnificum*. J Forest Res 15(5):337–340

Maeda T, Yoshioka J (1952) Studies on the vegetation of Chichibu Mountain forest. (2) The plant communities of the temperate mountain zone. Bull Tokyo Univ For 42:129–150+3pls (in Japanese with English summary)

Ohno K (2008) Vegetation-geographic evaluation of the syntaxonomic system of valley-bottom forests occurring in the cool-temperate zone of the Japanese Archipelago. In: Sakio H, Tamura T (eds) Ecology of Riparian forests in Japan: disturbance, life history, and regeneration. Springer-Verlag, pp 49–72

Saitama Prefecture & Kumagaya Local Meteorological Observatory (1970) Weather disaster of Saitama Prefecture. Saitama Prefecture & Kumagaya Local Meteorological Observatory. Saitama (in Japanese)

Sakio H (1993) Sapling growth patterns in *Fraxinus platypoda* and *Pterocarya rhoifolia*. Jpn J Ecol 43(3):163–167 (in Japanese with English summary)

Sakio H (1997) Effects of natural disturbance on the regeneration of riparian forests in a Chichibu Mountains, central Japan. Plant Ecol 132:181–195

Sakio H (2008) Coexistence mechanisms of three riparian species in the upper basin with respect to their life histories, ecophysiology, and disturbance regimes. In: Sakio H, Tamura T (eds) Ecology of riparian forests in Japan: disturbance, life history and regeneration. Springer-Verlag, pp 75–90

Sakio H (2017) A natural history of trees in riparian forests. University of Tokyo Press, 260 pp (in Japanese)

Sakio H, Tamura T (eds) (2008) Ecology of riparian forests in Japan: disturbance, life history and regeneration. Springer-Verlag, 339 pp

Sakio H, Kubo M, Shimano K, Ohno K (2002) Coexistence of three canopy tree species in a riparian forest in the Chichibu Mountains, central Japan. Folia Geobot 37:45–61

Sakio H, Kubo M, Kawanishi M, Higa M (2013) Effects of deer feeding on forest floor vegetation in the Chichibu Mountains, Japan. J Jpn Soc Reveget Tech 39(2):226–231 (in Japanese with English summary)

Sato T, Isagi Y, Sakio H, Osumi K, Goto S (2006) Effect of gene flow on spatial genetic structure in the riparian canopy tree *Cercidiphyllum japonicum* revealed by microsatellite analysis. Heredity 96:79–84

Suzuki T (1949) Temperate forest vegetation in the upper stream area of the River Tenryu. Sylvic Techn Gijitsu-Kenkyu 1:77–91 (in Japanese with English summary)