134. Jahrgang (2017), Sonderheft 1a, S. 101 – 130

Austrian Journal of Forest Science
Centralblatt für das gesamte Forstwesen

Household composition and aging of forest owners in Japan

Zur Haushaltszusammensetzung und Überalterung der Waldbesitzer in Japan

Koji Matsushita*, Yoshio Yoshida, Tetsuji Senda

Keywords: Demographic analysis, Population Census, World Census of Agriculture and Forestry, size of household, age of householder, planting, timber sales, forest management

Schlüsselbegriffe: Demographische Analyse, Volkszählung, Weltagrarzensus, Haushaltsgröße, Alter des Haushaltsvorstands, Anpflanzung, Holzverkäufe, Waldwirtschaft

Summary

The total population of Japan peaked in the 2010 Population Census. In view of the subsequent decrease in the total population, a recount of the 2000 World Census of Agriculture and Forestry was conducted to clarify the composition of forest owners' households and their forest-management practices. The largest age class among forest-owning householders was 65–69 years old, indicating that an aging tendency was already statistically apparent in 2000. Considering the average lifespan of Japanese

* Kyoto University
Corresponding author: Koji Matsushita (matsu@kais.kyoto-u.ac.jp)

people, the largest age class is currently probably around 75–79 years old. The following relationships between household composition and forest management were found. The percentage of households conducting planting and/or weeding and the percentage of timber sales were both low for one-person households. According to the recent population census, the percentage of one-person households is increasing; thus, it is likely that the percentage of one-person forest owners' households is also increasing. The peak age classes for planting and/or weeding and timber sales are 60–64 years and 70–74 years, respectively. These peak age classes are one age class before and after the peak age class of householders, respectively. The population is currently aging further; hence, the current peak age class of householders is significantly greater than the peak age of timber sales in 2000. These results suggest that the increase in the percentage of one-person forest owners' households and the aging of forest owners' households will affect whether forest owners decide to conduct final cutting of the coniferous plantation forests that were planted after the Second World War.

Zusammenfassung

Bei der Volkszählung im Jahre 2010 erreichte die Gesamtbevölkerung Japans ihren Höchstwert. In Anbetracht der danach abnehmenden Bevölkerungszahl wurde eine Nachzählung des Weltagrarzensus 2000 durchgeführt um die Zusammensetzung der Waldbesitzerhaushalte und die Art der forstwirtschaftlichen Bewirtschaftung aufzuzeigen. Die Nachzählung ergab, dass der Altersgipfel bei den Haushalten der Altersjahrgänge der 65- bis 69-Jährigen lag. Demzufolge offenbarten sich bereits im Jahr 2000 statistisch nachgewiesene Überalterungstendenzen. Angesichts der durchschnittlichen Lebenserwartung der japanischen Bevölkerung ist davon auszugehen, dass gegenwärtig die Altersgruppe der 75- bis 79-Jährigen am stärksten vertreten ist. Folgende Relationen ließen sich zwischen Haushaltszusammensetzung und forstwirtschaftlicher Bewirtschaftung feststellen: Bei den Einpersonenhaushalten fiel der Prozentsatz derer, die Anpflanzungen und/oder Unkrautbekämpfung durchführten sowie ihr Anteil an Holzverkäufen, niedrig aus. Nach den Ergebnissen der jüngsten Volkszählung ist der Prozentsatz der Einpersonenhaushalte im Steigen begriffen. Daraus ergibt sich, dass auch der Anteil der Einpersonenhaushalte unter den Waldbesitzern wächst. Die obersten Altersgruppen, die sich in den Bereichen Anpflanzungen und/oder Unkrautbekämpfung sowie Holzverkauf betätigen, sind 60 - 64 bzw. 70 - 74 Jahre alt. Sie befinden sich eine Altersklasse unter bzw. über den häufigsten Jahrgängen der Haushaltsvorstände. Die Alterung der Bevölkerung schreitet derzeit weiter voran, daher ist die Gruppe der aktuell im höchsten Alter stehenden Haushaltsvorstände signifikant größer als die der Holz verkaufenden Altersschicht. Diese Ergebnisse legen nahe, dass der Anstieg des prozentualen Anteils von Einpersonenhaushalten unter den Waldbesitzern darauf Auswirkungen hat, ob diese sich für oder gegen eine Endnutzung der in der Nachkriegszeit neu angelegten Nadelwaldplantagen entscheiden.

1. Introduction

The Japanese population reached a record peak of 128,057,352 people in the 2010 Population Census. A quick estimate based on the 2015 Population Census, announced in February 2016, indicated that the total population had decreased to 127,110,047, a decrease of 0.7% over 5 years (MIC, 2016). Out of all 47 prefectures, a decreasing population was observed in 39 prefectures between 2010–2015; thus the decrease in population is widespread across Japan with the exception of only a few prefectures.

The future population was estimated by the National Institute of Population and Social Security Research (2013) based on the results of the 2010 Population Census. If current trends in birth and death rates are maintained, which is the intermediate scenario, and discounting any mass emigration or immigration, the total future population of Japan was estimated to decrease from 128,057,000 in 2010 to 41,255,000 in 2110 (Figure 1). Within 100 years, the Japanese population will decrease to almost a third of the current population. It is clear that such a decrease in total population would have widespread socio-economic effects, including impacts on forest management.

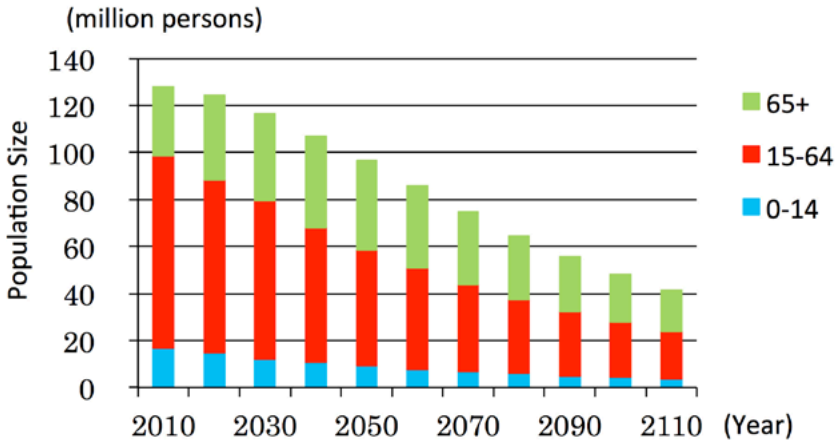

Figure 1: Predicted Population of Japan

Abbildung 1: Bevölkerungsprognose für Japan

Source: National Institute of Population and Social Security Research (2013) Population Research Series, No. 327, Table A-8, p. 79-80 (Estimation is based on average birth and death rates)

Research in Japan on the relationship between population and forestry has been conducted mainly from the viewpoint of the effects of the increasing population[1]. Various limitations in consumption or production in forests and food sources have been discussed worldwide, and the representative work is "The Limits to Growth" (Meadows, 1972). This analysis showed that, under finite natural resources, a rapid increase in total world population will lead to a decline in living standards and other complex issues. The background to this body of research rests on the basic idea that population increases will increase demands on natural resources, including forests. In Japan, after the Second World War, the total population increased to 84 million, 94 million, 105 million, 117 million and 124 million by 1950, 1960, 1970, 1980 and 1990, respectively, and this increase in total population was considered one factor leading to increasing demand for timber.

Although the population has increased overall, population migration from rural areas to urban areas began in the 1960s, and issues related to depopulation, particularly in areas where the main income resources were forestry-based, occurred at that time. Given the current decrease in the total population, there has been a new focus on the depopulation problem – namely, the possibility of local village disappearance (Masuda, 2014). The depopulation in mountainous areas started in the same period as Japanese high economic growth. At that time, many young villagers moved to urban areas, especially the three major metropolitan areas. The Rural Development Act (Act No. 64 of 1965) was established to support municipalities facing a population decrease. In 2010, this area and its population accounted for 47% and 3% of the total Japanese land area and population, respectively. Throughout Japan, the number of residents has decreased gradually, while the age of the remaining residents has increased gradually. If this continues, several small villages might become abandoned. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT, 2011) estimated future inhabited areas, and concluded that approximately 20% of current inhabited areas will become uninhabited by 2050. Approximately 90% of the current land use of these future uninhabited areas, and future inhabited areas with an estimated population density of less than 10 people per 1 km², is land currently used in the agriculture and forestry industries, such as secondary forest, plantation forest and agricultural land (MLIT, 2011). The government started the land management survey (MIC, 2011) after the disappearance of hamlets and reported that the percentages of hamlets in which farmland and forest had been abandoned were 50.0% and 46.3%, respectively.

A breakdown of the total population is shown in Figure 1. The percentages of the population in age classes 0–14 years, 15–64 years and 65 years and over are 13.1%, 63.8% and 23.0%, respectively in 2010, and those of 2110 are estimated to be 9.1%, 49.1% and 41.8%, respectively. As the total population decreases to one third of the current number, the percentage of the productive population within the age class 15–64 years will drop to less than 50%. That is, the total population is decreasing and aging simultaneously.

[1] For example, the Basic Plan on Forest Resources in 1966 made note of a future tight timber supply worldwide.

Aging of the population can be seen in some industrialized and developed countries. Figure 2 shows the percentages of people aged 65 years and over in Japan and several other developed countries (Cabinet Office, 2015) based on "World Population Prospects" from the United Nations. The Japanese percentage of elderly people was lower than that of other developed countries in the 1960s and the 1970s, but the percentage increased rapidly around 2000 (Cabinet Office, 2015). Currently, the percentage of elderly people in Japan is the highest among these developed nations, and this will continue in the future. The rapid increase in the percentage of elderly people is a striking characteristic of Japanese demographic figures. In Japan, all industries, including forestry[2] and wood-related industries, are facing a demographic crisis.

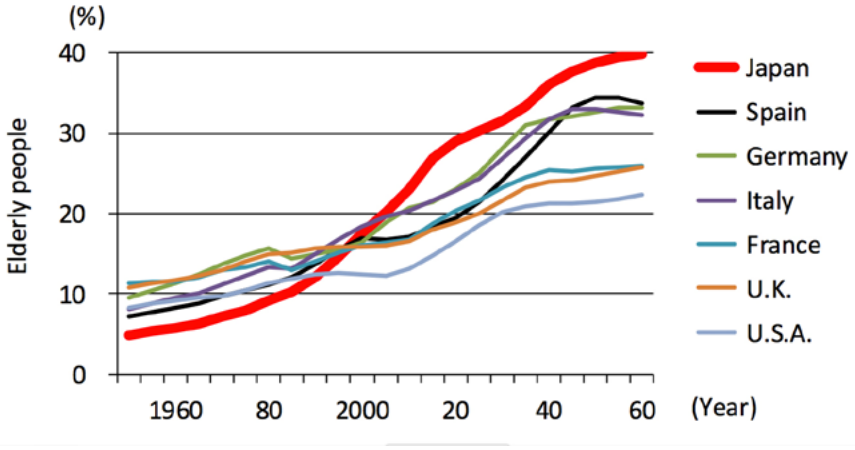

Figure 2: Prediction of percentage of population aged 65 years and over

Abbildung 2: Prognose des Anteils der Bevölkerung ab 65 Jahren und älter

Source: Cabinet Office Japan (2015) Korei shakai hakusyo (Annual Report on the Aging Society), 2015 U.N. World Population Prospects, The 2012 Revision

Here, planting activities in Japan will be explained (Matsushita, 2015). Many plantation forests of *Cryptomeria japonica* and *Chamaecyparis obtusa* were created between the 1960s and 1980s, of which 73.9% by volume is now private forest. It should be noted that whether plantation forest resources are cut and used depends on decisions made by private forest owners based on timber quantities. Considering the changes in the total Japanese population, the composition of forest-owning households has not yet been widely studied, mainly because, under an increasing population, household-level information was not necessary. In addition, during the 1960s and the 1980s, go-

[2] In this paper, the aging issues of forestry workers are not analyzed. The average age of forestry workers was 56.0 and 52.1 years according to the Population Census in 2000 and 2010, respectively (Forestry Agency, 2016). Since the Japan Standard Industry Classification changed in 2007, it is difficult to compare the average ages between 2000 and 2010; however, both were clearly younger than the average age of forest owners, as discussed below.

vernment policy targets were to increase the area of plantation forest[3], and the most important factor in implementing this intention was subsidy programs, rather than the decision-making and income requirements of forest owners. As well as the composition of forest owners' households, the relationship between the composition of these households and their forest practices will also be analyzed to consider future timber production under the demographic changes shown in Figures 1 and 2.

An analysis of recent forest practices by private forest owners identified several serious issues. First, the number of non-residential forest owners is increasing. In addition, the number of residents in mountainous areas is decreasing, while their average age is increasing more rapidly than that of the total Japanese population. In addition, the number of forests with owners unknown to residents and local forestry-related workers is increasing. Due to the increases in non-residential and elderly owners, information on forest unit boundaries is disappearing. These issues are interrelated. The Forestry Agency strongly promoted their plantation policy after the Second World War. As a result, many plantation forests are now available for use; however, recently, serious issues related to their ability to be used have arisen, including an increase in unknown ownership and unclear forest unit boundaries. The Forestry Agency started to conduct countermeasures for such situations, including the amendment of forest-related acts[4] in 2016.

To consider forest management in the future, a demographic analysis of private forest owners is necessary. Only private forest owners who engage in both agriculture and forestry can be analyzed using current statistics in Japan. Kohroki (2009) and Sato (2013) have analyzed the current situation, but the dataset they used included a limited number of households.

Therefore, our research had two objectives. The first objective was to clarify the characteristics of all households that own forests. To address this objective, data from the 2000 World Census of Agriculture and Forestry (hereinafter, denoted as the "Agriculture Census", "Forestry Census" or "Census"), the last national statistical survey of all households owning forests over 1 ha (for survey results, see Shiga (2002)) were analyzed, focusing on households that engaged in both agriculture and forestry, with a particular emphasis on the composition and aging trends of the owners. The second objective was to clarify the relationship between demographic characteristics and forest practices, such as whether there is a relationship between age and planting activities. Understanding such relationships may provide useful information for assessing forest practices under future demographic conditions, as shown in Figures 1 and 2.

The contents of this paper are as follows. The data used, as well as related explanations and definitions, are described in Section 2. The analysis results from the Census are given in Section 3 and 4. In Section 3, the size of forest owners' households and the age

[3] The issue of aging forestry workers has been examined in Japan. The percentage of forestry workers over 65 years of age increased during the 1990s, accounting for 14% and 30% according to the 1990 and 2000 Population Censuses (Forestry Agency, 2016). For a statistical analysis from the time, please see Nagata et al. (1991).

[4] In May of 2016, five acts relating to forestry were partially amended at the same time, including the Forest Act (Act No. 249 of 1951), Act on Special Measures concerning the Benefit-share Forest Act (Act No. 57 of 1958), Forest Owners' Cooperative Act (Act No. 36 of 1978), Act on Special Measures concerning the Securement of Stable Supply of Timber (Act No. 47 of 1996), and Act on Special Measures concerning Forestry and Forest Products Research Institute (Act No. 198 of 1999).

of householders are discussed. In Section 4, the relationship between the results from Section 3 and forest practices are demonstrated. In Section 5, the effects on timber production of recent demographic changes are discussed. In the final section, conclusions and future research topics are presented.

2. Method

The Forestry Census, which has been undertaken by the Ministry of Agriculture, Forestry and Fisheries (MAFF) since 1960, is the only set of statistical data on forest owners in Japan. Until the 1990 survey, the minimum holding area for owners in the survey was 0.1 ha. The number of private forest owners was 2,508,605 and the number of forestry entities other than private forest owners, such as companies, joint holdings, etc., was 354,318 (Forestry Agency, 1995). In 2000, the minimum holding area increased from 0.1 ha to 1 ha, and the number of forest owners and forestry entities greatly decreased, to 1,018,752 and 153,036, respectively (Forestry Agency, 2002).

In 2005, the survey method used in the census was completely revised, and the Agriculture Census, which started in 1950, and the Forestry Census were combined into one survey. After this reform, the survey target changed completely. Until 2000, the survey target was forest holders with a certain minimum holding area. After the 2005 survey, the concept of a Forestry Management Entity (Ringyo keieitai) was introduced, for which at least one of the following four conditions had to be satisfied:

1) Held at least 3 ha of forest, and conducted forest practices and/or cutting during the previous 5 years.

2) Held at least 3 ha of forest, and had a Forest Management Plan under the Forest Act (Act No.249 of 1951) that included 2005.

3) Conducted planting and/or forest practices as commissioned by the forest owner in the previous year.

4) Produced at least 200 m^3 of logs, as commissioned by the forest owner, and/or by purchase of stumpage in the previous year.

The number of Forestry Management Entities as defined above was 200,224 in 2005, significantly less than the total number of private forest owners and forestry entities in 2000. The numbers of Forest Management Entities in 2010 (Forestry Agency, 2015) and 2015 (MAFF, 2016) were 140,186 and 87,284, respectively.

In this study, census data after 2005 could not be used to clarify the overall situation of forest owners, as the number of surveyed forest owners was too small. The 1990 Census contains the largest dataset on forest holders, because the minimum holding in that year was 0.1 ha; however, individual data from the 1990 Census are no longer available. Therefore, the 2000 Census was used, which was the last survey conducted under the former method.

Before 2000, the Agriculture Census and the Forestry Census surveys were conducted, analyzed and published separately. Household-level information was included in the Agriculture Census only, and the same identification numbers were used for respondents for whom both the Agriculture Census and the Forestry Census applied. To attain the objective of this study, we selected respondents who were survey targets of both censuses, and combined the household data from the Agriculture Census with the forestry data from the Forestry Census to create a new dataset for this analysis. As the onsite survey in the Forestry Census was conducted for respondents with a minimum forest holding area of 3 ha, households meeting this condition were included in the analysis. Among 1,018,752 private forest owners in the 2000 Forestry Census, 283,839 owners were selected who met the above conditions, corresponding to 27.9% of the total. The percentages of the 283,839 owners classified by holding area are shown in Figure 3; the percentage holding 50 ha or more was only 1.9%.

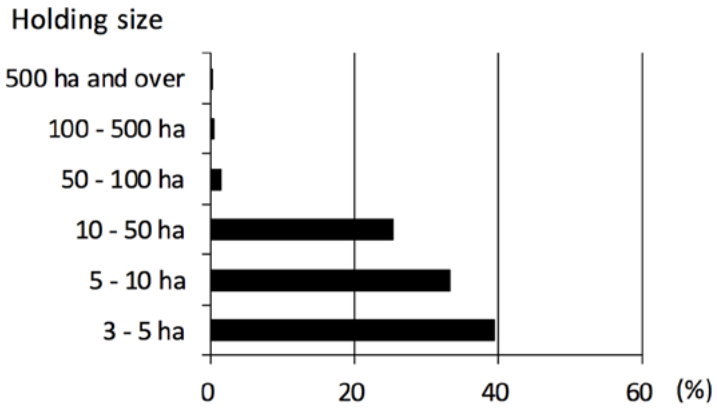

Figure 3: Holding area of forests

Abbildung 3: Forstwirtschaftliche Betriebsfläche

Source: Recount results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

Hereinafter, these 283,839 households are denoted "forest owners' households" or sim-

ply "households". In this paper, households and householders were defined in the resident register managed by municipal offices under the Basic Resident Registers Act (Act No.81 of 1967). 'Household' refers to people who share housing and livelihood; thus, people other than families and relatives may be included. In cases where the house is shared but there are separate livelihoods, the households are considered separately in the residents' register.

The householder plays the primary role in the household. Generally, in Japan, forest ownership is held by the oldest family member in the household, and forest ownership is seldom gifted before death. In agriculture, significant work is required to maintain farmland; however, in forestry, the daily workload is light, particularly for small-scale holdings, and the necessary forest practices can be entrusted to local forest owners' associations or forestry companies. Thus, forest inheritance usually occurs at death. In this paper, the householder is considered the legal forest owner; however, in some cases, the legal owner may have been older than the householder. In contrast, it is also possible that the legal owner was younger than the householder.

The Forestry Census surveyed forest management by household, including forests rented from other owners, but excluding forests lent to other owners. As the percentages of rented forest and lent forest are generally low, in this paper, data from the Forestry Census are used as data for forest ownership. All figures and graphs calculated from recounting the 2000 Census are shown in percentage form, based on a total of 283,839 owners.

Finally, elderly people are defined in this paper as those aged 65 years or over, in accordance with the classification (MIC, 2005) in the Population Census of Japan.

3. Household characteristics

3.1. Household size

Data on the size of forest owners' households in the 2000 Census were recounted, as shown in Figure 4. Two- to-seven-member households accounted for about 10% to 20% of households. Two- person households were the most prevalent household size. The percentage of one-person households was low in 2000.

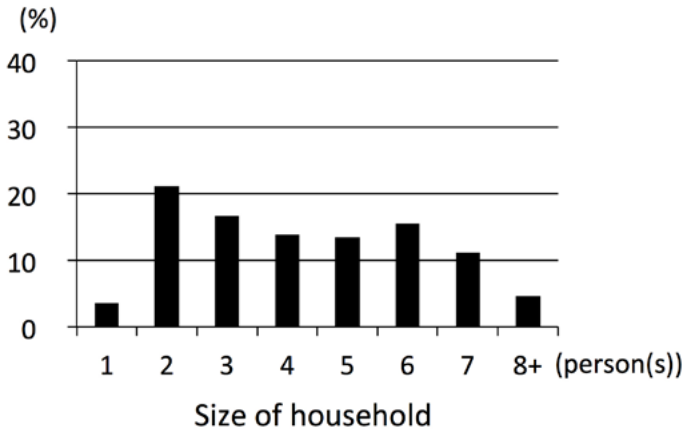

Figure 4: Size of household

Abbildung 4: Haushaltsgröße

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

Household sizes for the whole of Japan based on the 1960 and 2010 Population Censuses are shown in Figure 5. In 1960, four-person households formed the largest proportion of the total; however, in 2010, one-person households formed the largest proportion, and the total percentage of one- and two person households reached 59.6%. The total percentages in 1960, 1980, 2000 and 2010 were 17.9%, 36.6%, 52.7% and 59.6%, respectively. After 2000, more than half of all households consisted of less than two people.

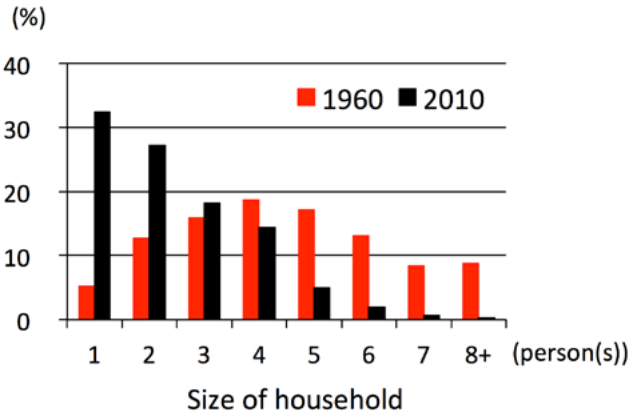

Figure 5: Household size among the Japanese population

Abbildung 5: Haushaltsgröße laut Volkszählung

Source: Statistics Bureau, Ministry of Internal Affairs and Communications: Japan Statistical Yearbook (1982 ed., 2016 ed.)

As shown in Figure 4, the total percentage of one- and two-person households was 28.4%, which is approximately half of the total found in the Population Census. As already discussed, the percentage of elderly people is currently increasing, and the total population reached a peak in 2010; thus, it is likely that the percentage of one- and two-person households is also increasing among forest owners' households.

3.2. Age of householders

The age classes of householders, with a 5-year interval, are shown in Figure 6. Inheritors of agricultural management are also shown for reference. Agricultural inheritors aged 15 years or over are shown as a survey item in household information in the Agriculture Census, including any planned inheritance.

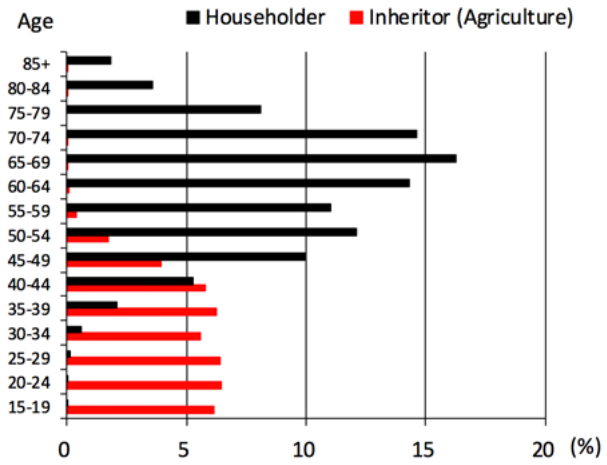

Figure 6: Ages of householders and inheritors

Abbildung 6: Alter des Haushaltsvorstands und der Erben

Note: The inheritor (agriculture) data does not equal 100%, because cases of inheritors living outside the village and cases with no inheritor are excluded.

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

The 65–69 years age class contained the highest percentage of householders; the percentage of elderly householders was 44.4%. The percentage of householders aged 50 years and over in the 2000 Census, who will be elderly in 2015, reached 81.9%, demonstrating that the aging of forest owners in Japan was already developing in 2000.

The 2000 Population Census revealed that the 50–54 years age class contained the highest proportion of the population across the whole of Japan, and the peak age was 51 years old. The most recent population estimate using 5-year intervals showed that the 65–69 years age class contained the highest proportion of the population (Statistics Bureau, 2016). Based on these figures, the peak age class of forest owners' householders appears to have shifted from 65–69 years in 2000 to around 75–79 years in 2015, considering that the average lifespan of Japanese people in 2014 was expected to be 80.50 years for men and 86.83 years for women (MHLW, 2015) and that the average remaining life time of Japanese people 65 years of age in 2000 was 17.43 years for men and 22.44 years for women[5] (MHLW, 2000). The aging of individual forest owners within householders in Japan seems to be reaching a crisis level. It appears that the

[5] Ministry of Health, Labor and Welfare (MHLW) Heisei 12 nen kanni seimeihyo (Simple life table in 2000 in Japan), http://www.mhlw.go.jp/toukei/saikin/hw/life/life00/, 2016/07/16 (in Japanese)

total percentage of owners over 80 years old, and number of forests recently inherited by younger owners, is increasing year after year.

Agricultural inheritors were distributed almost equally from the 15–19 years age class to the 40–44 years age class. Households in which the inheritor was a current occupant comprised 42.9% of the total, while households in which the inheritor lived elsewhere comprised 16.1%. Households in which there was no inheritor comprised the remaining 41.0% in 2000. The percentage of households with no inheritor is likely to be higher in current data[6]. In the case of agriculture, some work is necessary to continue the business; in contrast, forest inheritors can own a forest simply for the purpose of maintaining household property. If the inheritance was conducted simply for the purpose of keeping family property, no forestry practices and/or family labor will be conducted by the owner.

4. Forestry practices by household characteristics

In this section, we will describe the recounted forest practices results, classified by household size and householder age. Two forestry practices will be considered: planting and/or weeding, which is generally necessary for 5–10 years after planting in Japan, and will simply be denoted as "planting" hereinafter; and forest products sales, including the sale of logs from thinning. Forest product sales is further divided into two categories: timber sales and non-timber forest products (NTFPs) sales, which include all forest products other than timber. In all figures in this section, "percentage" denotes the percentage of households that conducted planting or sales during the year before the survey.

4.1. Planting

Figure 7 shows percentages of planting according to household size. It is clear that the percentage from one-person households was low. The percentages from two- to five-person households were almost equal, and those of six-person households or greater are slightly higher.

[6] Current data for the information shown in Figure 6 is not available. The only available data is the percentage of farm households with farm land of at least 0.3 ha and that have made sales of farm products in the past 1 year over 500,000 yen. In the 2010 Census, the percentage of households with no inheritor was 58.6% (inheritor living outside the village, 18.0%; no inheritor, 40.6%). In the 2015 Census, the percentage of households with no inheritor was 70.1% (inheritor outside the village, 18.8%; no inheritor, 51.3%).

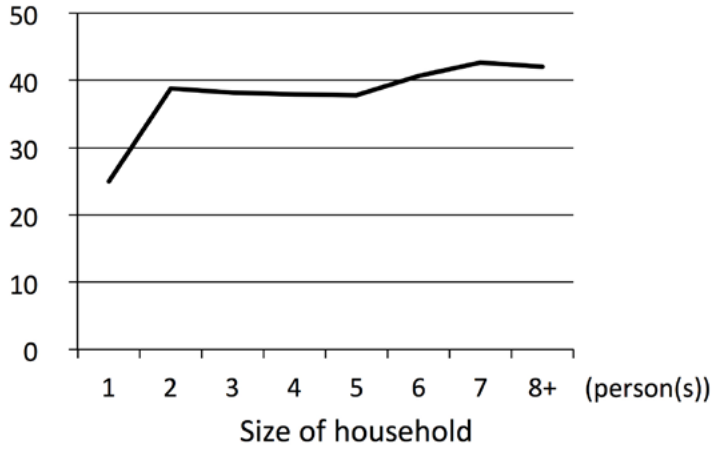

Figure 7: Planting by size of household

Abbildung 7: Bestandesbegründung nach Haushaltsgröße

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

As shown in Figure 4, in 2000, the percentage of one-person households remained low, while two-person households were the most prevalent. Considering that the 65–69 years age class contained the highest percentage of householders, as shown in Figure 6, two-person households included a high number of elderly men and their wives, and it is probable that, recently, a significant number of these households became one-person households. Hence, the percentage of one-person households, in which the percentage of planting is clearly low, is likely increasing.

The percentage of planting activity as a function of householder age is shown in Figure 8, where the peak is in the 70–74 years age class; i.e., one age class higher than the peak age of householders. In householders over 80 years old, the percentage decreases to a level almost identical to that found in householders in their 40s or 50s.

Figure 8: Planting by householder age

Abbildung 8: Bestandesbegründung nach Alter des Haushaltsvorstands

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

One reason that the peak age is in the 70–74 years age class is that forest owners can obtain subsidies for planting and weeding. In addition, forest owners' associations can undertake planting and weeding tasks for the forest owner and receive this subsidy.

4.2. Forest products sales

The percentages of forest products sales classified by household size are shown in Figure 9. The pattern differs between timber and NTFPs, such as mushrooms. For both, the percentages tend to increase with increasing household size. However, in the case of timber sales, the percentage for one-person households is extremely low, and that for two- and three-person households is slightly higher than that for four- and five-person households. The increasing tendency in the percentage of one-person households indicates that the percentage of households in which the percentage of timber sales is low is increasing.

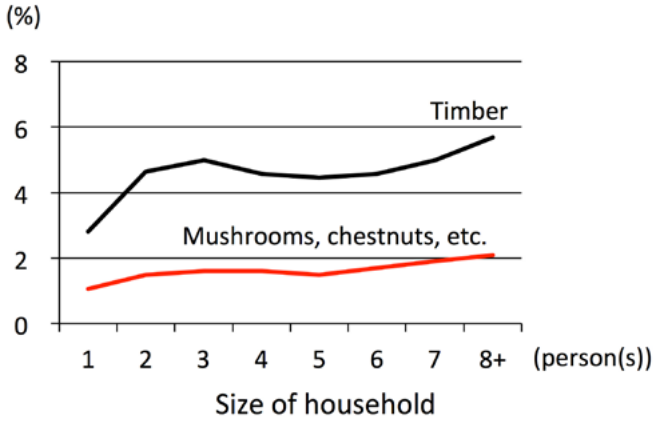

Figure 9: Forest products sales by household size

Abbildung 9: Verkauf forstwirtschaftlicher Produkte nach Haushaltsgröße

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

The percentages of forest products sales classified by householder age are shown in Figure 10. In the case of timber sales, the peak is in the 60–64 years age class, which is one age class lower than the peak householder age class of 65–69 years. For householders aged over 75 years, the percentage decreases to almost the same level as for householders in their 20s or 30s. In the case of NTFPs, the percentages are almost equal between 35 and 74 years old, and the percentage over 80 years old decreases to almost the same percentage found for householders in their 20s.

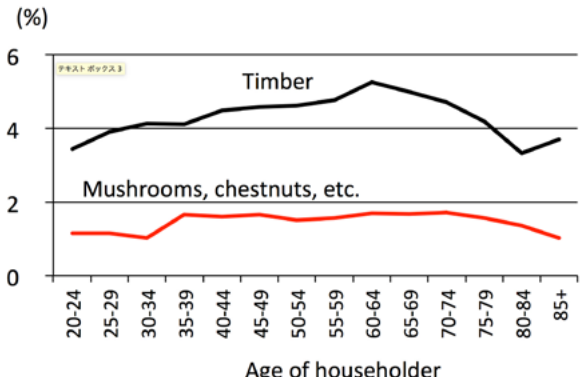

Figure 10: Forest product sales by householder age

Abbildung 10: Verkauf forstwirtschaftlicher Produkte nach Alter des Haushaltsvorstandes

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

5. Discussion

5.1. Changes in household size and their effects on forest practices

Based on the Population Census, it is evident that the percentage of one-person households increased from 5.2% in 1960 to 19.8% (1980), 27.6% (2000) and 32.4% (2010). There are many reasons why the percentage is increasing, including the death of a partner among elderly people, an increase in unmarried people in the younger age groups[7], and fewer parents and children living together. Lifespans are increasing and the birth rate is decreasing. Young people change their living situation due to taking a job or going to school, and elderly people change their living situation to acquire medical assistance or to enter care facilities. As these trends continue, the increase in the percentage of one-person households will also continue.

Why the percentages of planting and timber sales decreased in one-person households is not clear from this analysis, and future statistical research and a field fact-finding survey are necessary. Here, instead, the recounting result relating to the relationship between generations and households will be discussed. First, households were separated into one-generation, two-generation, three-generation and 'other' classes. One-generation households were further divided into man-only, woman-only and couples. Two-generation households were divided into those that included the householder's generation plus parent(s), child(ren), or 'other'. Three-generation households were divided into those containing the householder's generation plus parent(s)+child(ren), grandparent(s)+parent(s), child(ren)+grandchild(ren), or 'other'. All households not described in the above categories were included in 'other'. As household members share both housing and livelihood, combinations that cannot be classified into the categories above occur. In addition to these classifications, information on the importance of agriculture was added, which cannot be analyzed within the scope of this paper. More specifically, households were divided into four categories: full-time farming household, part-time farming household (category 1: agricultural income is greater than other incomes), part-time farming household (category 2: agricultural income is lower than other incomes) and subsistence-farming household (cultivated land is less than 0.3 ha and annual agricultural income is less than 500,000 yen). The results are shown in Figure 11.

[7] The major cause for the current birth rate decline is the tendency to marry later or to remain unmarried (Kono, 2007).

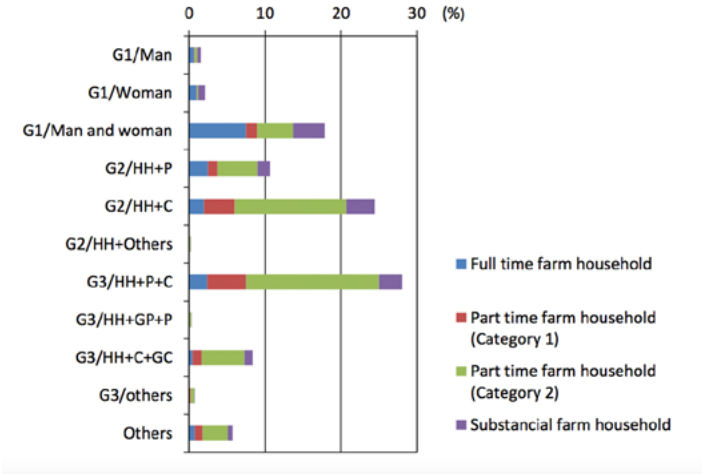

Figure 11: Detailed compositions of farming households with forest

Abbildung 11: Detaillierte Zusammensetzung land- und forstwirtschaftlicher Haushalte

Source: Recounting results of the 2000 World Census of Agriculture and Forestry (n = 283,839)

Note: G1, G2 and G3 denote one-, two- and three-generation households, respectively. HH denotes the householder or householder plus marital partner. GP, P, C and GC denote grand parent(s), parent(s), child(ren) and grand child(ren), respectively.

The following are the four major combinations in the 2000 Census, which can be seen in Figure 11.

(A) Three generations comprising the householder's generation, parent(s) and child(ren).

(B) Two generations comprising the householder's generation and child(ren).

(C) One generation including a husband and wife.

(D) Two generations comprising the householder's generation and parent(s).

These four combinations account for 81.1% of the total.

Combination (C) represents the largest percentage of full-time households, which are two-person households containing a man and his wife. Many of these households are elderly, and the death of one member will yield a one-person household. These house-

holds are likely to have been working in agriculture together almost full-time for many years, and after becoming a one-person household, the householder will downsize the business such that it will remain manageable. It is probable that the connection to their forest will decrease after becoming a one-person household. Considering the difference in life expectancy between men and women, the percentage of women will increase in elderly one-person households. In this case, the percentage of planting and timber sales will decrease.

In combination (D), after the death of the elderly parent, the household will change to combination (C). In cases where the householder is elderly, the householder will change to one-person household status in the near future.

Most households in combinations (A) and (B) are part time farming households, mostly in category 2, where the income from agriculture is less than other income sources. It seems likely that, in these households, the dependence on forestry product income was small.

In combinations (A) and (D), the parent(s) of the householder generally seem to be old. It is probable that the parent has ownership of the forest. Although we considered the forest-holding householder as a forest owner in this paper, it is possible that the age of the legal owner is higher than the analyzed age in these combinations. In these combinations, the main income is provided by the householder, and the householder's parents also live in the household. Thus, it is important to understand how forest management or forest holding information is transferred, and this will be covered in future research.

5.2. Aging and forest practices

As shown in Section 4, it is important for timber production that, at the time of the 2000 Census, the peak age class for timber sales was 60–64 years, which is one age class lower than the peak age class of householders. However, it is important to consider the situation now, almost 15 years later, after the final census survey was undertaken using the former method. The peak age class of householders is estimated to be around 75–79 years. Although the peak percentage of planting or timber sales will also be related to economic conditions, including timber prices and forestry policies (such as subsidies), it is possible that the peak has not changed significantly compared to the situation in the 2000 Census.

For timber sales, changes in the average stumpage price must first be discussed to explain the economic situation. The price index (1980 = 100) decreased to 10.9 and 15.1 for *Cryptomeria japonica* and *Chamaecyparis obtusa*, respectively, which are the two major species of plantation trees in Japan, by March 2013 (Forestry Agency, 2015). This price was the lowest recorded, although the value recovered by March 2014, to 13.1 and 17.5 for *Cryptomeria japonica* and *Chamaecyparis obtusa*, respectively. Under

these price conditions, no factor can be cited to explain a move in peak timber sales to an older age class. In the case of an elderly householder, especially those aged around 80 years, it seems likely that the basic management practice changes from cutting for profit to forest maintenance for the next generation. In any case, the percentage of timber sales by householders of 75–79 years will be low. Considering that the lifespans of healthy men and women are 71.19 and 74.21 years (Cabinet Office, 2015), respectively, in 2013, migration of people in the 75–79 year age class for health reasons will increase.

Recently, planting areas have decreased, due to decreases in clear cutting of coniferous trees and areas in which broad-leaved natural forests are cut and coniferous trees are planted, mainly for construction wood. As the area of planted forest decreases, the area requiring weeding also decreases. Thus, the level of planting and/or weeding is currently very low across all age classes, and the peak age class at which these tasks are undertaken is unclear.

To summarize, it is evident that the peak age class of householders is currently significantly higher than that of peak timber sales. Sato et al. (2006) analyzed a case in Yamaguchi Prefecture, Chugoku region, using a questionnaire survey; 53% (n = 704) of the total respondents were older than 70 years at the time of the survey, in 2003. Aging was more serious in this case than our results (Fig. 3). Conversely, according to the results of the 2010 Census, the average age of the managers of family forest management entities (Kazoku Ringyo Keieitai) was 66 years (Forestry Agency, 2016). This is younger than our estimate of the current average age of forest owners. One reason for this discrepancy may be that the survey target of the 2010 Census was limited by the introduction of the new definition of management entities, as discussed in Section 2, and that the average was calculated based on the manager of these management entities. In contrast, our study focused on householders, i.e., family members. Thus, the current statistics fail to reveal the very serious aging problem among private forest holders. Regardless, the actions of elderly people, especially those older than 75 years, must be studied in future research using improved survey methods.

Other cases in developed countries may be considered in future research. In this study, age-related variables were analyzed in terms of their age-class distributions. The average age of all 283,839 householders included in this study was 61.6 years. Hayrinen (2015) investigated forest owners in Finland using a questionnaire survey. Based on 557 valid responses, the average age of forest owners was 62 years during the survey year (2011/2012). Given that the average in 2011/2012 was almost equal to the Japanese average in 2000, aging appears to be a more serious issue in Japan; however, the two cases share similar demographic conditions and influences related to forest management.

5.3. Issues in plantation forest caused by aging

Coniferous trees were planted intensively during the 1950s and 1970s, and the Forestry Agency (2016) states that the percentage of plantation forests in the age classes of 46–50 years or over is 51% of the total plantation area. A future increase in timber production has been planned in the current Basic Plan on Forests and Forestry[8]. In the newest basic plan, published in May 2016, domestic timber production is to increase 1.7-fold from 2014 to 2025.

In the case of privately owned forests, timber production predictions based on past data may be overestimated, considering the demographic conditions discussed in this paper. Even if market and resource conditions are satisfied based on past experience, it is not clear if the final cutting decision will be made by elderly forest owners, especially those aged 80 years or above.

Although the basic conditions, assumptions and scenarios in the Basic Plan on Forests and Forestry are undisclosed, it is probable that detailed demographic data, such as household size and householder age, are not included. The decrease in the total population started in 2010; thus, it is difficult to extract the variables most related to demographic aspects of timber production for inclusion in a prediction model of domestic timber production. The possibility of introducing demographic factors into the timber production model should also be a topic for future research.

As shown in Figure 2, one of the characteristics of Japanese demographics is the rapid increase in average age, alongside almost no changes in the forest ownership system or forest practices. What are the current issues directly connected to domestic timber production? Here, we would like to refer briefly to two issues: forest unit boundaries, and forest inheritance.

First, issues relating to forest unit boundaries should be discussed. The depopulation problem in mountainous areas started during a period of fast Japanese economic growth, when forest inheritors left for urban areas. The total number of remaining family members decreased while their average age increased significantly. The problem here is that information on forest unit boundaries is mostly held by forest owners. Most planting and weeding operations have been conducted by local forest owners' associations, but consolidation of forest owners' associations was promoted by the Forestry Agency, such that the number decreased from 5,138 in March 1954 to 660 in March 2013. As a result of this consolidation, communication between associations and local villages weakened, and the number of association workers familiar with the situation at the time of planting decreased, while their population aged. Boundary certification of forest owners' associations is now difficult.

[8] Forestry Agency, http://www.rinya.maff.go.jp/j/kikaku/plan/index.html, 2016/06/21 (in Japanese)

All land information, including forest information, is managed by register offices. The problem is that almost half (MLIT, 2016) of the public maps in register offices were created during an era of land tax reform, beginning in 1873 (associated with the Meiji Restoration), and lack detailed measurements. Thus, there are differences between public maps and the real situation in many areas. After the Second World War, the National Land Survey Act (Act No.180 of 1951) was enforced, and land survey projects were conducted by municipal offices. To promote the surveys, the Act on Special Measures for Promotion of the National Land Survey (Act No.143 of 1962) was enforced, and a 10-year plan was created to promote land surveys. However, the percentage of areas where land surveying was completed was 51% of the total Japanese land area, and 44% of the total forest area (MLIT, 2016; Forestry Agency, 2016). The numbers of municipalities where land surveying has been completed, undertaken in practice, is currently on hold, or has not been introduced at all are approximately 28%, 45%, 16% and 10%, respectively. MLIT (2016) has pointed out that one of the reasons why the land survey project was not developed in mountainous areas was the increase in the percentage of elderly forest owners and forest owners living outside villages. MLIT (2016) also referred to the fact that the physical evidence and personal evidence necessary to certify land boundaries are disappearing.

MAFF (2015) prepared a questionnaire-based survey of forest resources for forestry monitors in 2015, including questions related to boundary certification. The reasons for the lack of success of the boundary certification project were queried with multiple possible answers, but the most frequently chosen answer (64.5%) was that some people owned a forest by inheritance but did not know the exact location of their forest. The next most frequently chosen answers were the lack of development of the Land Survey project by municipalities (45.5%) and that forest owners could not participate in on-site boundary certification due to their extremely old age (39.7%). These results suggest that the increase in the number of new owners who recently inherited forest but have no experience of forest practices or have not visited their forest affects issues related to boundary certification. The increased percentage of elderly people ultimately leads to an increase in younger, new forest owners through inheritance, which then poses challenges to boundary certification. Thus, clarification of forest ownership and correct forest boundaries is urgently needed to promote cutting activities in private forests.

The Forestry Agency is now promoting the creation of a Forest Management Plan (FMP) based on the Forest Act, to promote the intensification of forest practices by small-scale forest owners. At the end of the 2014 fiscal year, the percentage of forests where an effective FMP had been created was approximately 28% of the total non-national forest (Forestry Agency, 2016). One problem that has also been identified with respect to obtaining forest owners' agreement to intensify forest practices is that staff could not clarify forest boundaries due to the aging and absence of forest owners.

Forest owners cannot access sufficient subsidies without an official FMP; thus, forest practices and timber production may not increase as much as expected by the Forestry Agency.

The problems surrounding forest inheritance will also be discussed briefly. In Japan, forest ownership is transferred under the inheritance system. Formerly, the eldest son was bestowed the status of family head and all property including forests; however, this system ended with the amendment of the Civil Code in 1947. After 1947, forest succession has related mainly to family members or relatives living in the village, although the number of successors living outside the village has increased. In the case of a village where most of the residents are elderly, such that the village will disappear in the near future, it is possible that almost all forests in the village will be owned by people living elsewhere, and clarification of forest unit boundaries will become almost impossible. Therefore, forest ownership and forest boundaries must be clarified urgently based on the knowledge of elderly forest owners, most of whom are estimated to be in the 75–79 years age class.

Furthermore, at present, there are many cases in which no inheritor exists. According to the Justice Statistics[9] of 1995, 2000, 2005, 2010 and 2014, the number of cases seen by the administrator for property of the Family Court, in which inheritance was unclear, was 4,696, 7,639, 11,902, 15,083 and 19,562, respectively[10]. Furthermore, the number is increasing. As the percentage of one-person households increases, the number of such cases will also increase. The MLIT has predicted a four-fold increase in these cases by 2050, and a corresponding increase in land for which ownership is unclear (MLIT, 2011).

As shown in Section 4, the percentage of timber sales when the householders are aged 75 years or above decreases to the level of those where the householders are in their 20's. This indicates that the percentage of timber sales is low for both elderly forest owners and young forest owners who have just inherited a forest. The increase in the percentage of elderly owners will lead to a decrease in timber sales, including a decrease in timber sales by young inheritors, many of whom seem to be living outside the village. From this, it seems possible that final cutting will not be conducted at the level predicted by the Forestry Agency.

The issues surrounding forest inheritance are related to the fact that succession at the time of death follows the usual system. As seen in Figure 5, in 1960, households contained many family members in multiple generations. When multiple generations live together, the system of inheritance at the time of death does not cause problems in the transfer of forestry-related information. Even when the legal owner is the oldest person in the household, the inheritor can learn about forest management practices from the older multiple generations in the household. Sato (2009) found that the average age of female family forest management entities (Kazoku Ringyo Keieitai) was 6.1 years older than male family forest management entities, using the 2005 Census,

[9] Courts in Japan, http://www.courts.go.jp/app/sihotokei_jp/search, 2016/06/30 (in Japanese)

[10] These numbers are for all cases. The number of cases relating to forests is not clear in the Justice Statistics.

which was conducted following a different survey method than the 2000 Census, which we used. Sato (2009) suggested that this shows a failure of succession to the younger male generation after the death of the former male manager[11].

Given the current situation of decreasing total population and aging across Japan, the forest inheritance system should be assessed, which should be a topic for future research.

5.4. Policy direction for forests when the owner and/or boundary are unclear

In this study, the characteristics of households who conducted planting, weeding and forest product sales were analyzed from the perspective of demographic changes. Over the next 100 years, the population of Japan is predicted to decrease by one-third of the current population (Fig. 1). In addition, the number of residents living in mountainous areas is decreasing. Aging of forest owners is on the verge of becoming a crisis, and the percentage of households without an inheritor to manage the forests is increasing (Fig. 6). Moreover, the percentage of forest owners living outside villages is increasing, a trend that will continue in the future.

Cases where the forest owner is unknown to local residents, forestry-related workers or local forest owners' association are increasing. As shown in Section 5.3, correct boundary information is typically held in the memories of elderly forest owners, which is facing a complete loss due to aging. Here, we discuss how forests are managed when the owner and/or boundary are unclear, especially from the perspective of current policy directions, and suggest future research topics.

Article 9 of the Basic Act on Forest and Forestry (Act No.161 of 1964) outlines the obligation of forest owners, stating that forest owners must make an effort to improve and protect their forest to secure the multi-objective functionality of the forest. Although concrete measures and penalties are not included in the act, it is clear that the forest owner is obligated to manage the forest, at least in a legal framework.

The number of households without an inheritor to oversee farm management is increasing (Fig. 6); in such cases, legal successors will inherit the forest. In cases with no legal successor, other relatives can inherit the forest. In cases with no relatives, a property executor is appointed who will search for another appropriate holder besides a relative. When it has been certified that there is no appropriate holder for the forest, the forest becomes government property. Under the current framework, cases where forests can become government property are limited.

Forests with legal owners unknown to local residents or local forestry workers and organizations are becoming a major issue. Moreover, cases with no legal successors

[11] In the 2005 Census, the percentage of male and female managers of family forest management entities (Kazoku Ringyo Keieitai) were 93.5% and 6.5%, respectively (Sato, 2009), indicating that men accounted for a much greater proportion of managers.

and no residents remaining in the village are increasing. In this analysis, households participated in both agriculture and forestry; however, the situation is even less clear for households who own forested land but do not conduct agriculture. There is a high possibility that these owners live outside the village, and villagers have no information regarding the owners or their future successors. Moreover, issues related to forests with owners unknown to residents will likely become more serious in the future.

With the amendment of the Forest Act in May 2016, a new system was introduced to improve the registration of forest land with municipal offices, the details of which are now under consideration. Because municipal offices have administrative rights related to the recognition of the FMP and submission of harvesting reports, municipal offices will face difficulties in the future due to an increase in the number of non-residential forest owners and successors.

Until now, information regarding forest land was managed by several offices separately, including land surveys conducted by municipal offices, land registries managed by municipal offices, non-national forest resource databases (Shinrinbo) managed by the department of forestry of the prefectural government (Matsushita et al. 1998), and the official FMP under the Forest Act. With the amendment of the Forest Act in April 2011, a new rule that new forest landowner must submit a report to their municipal office was added; thus, the municipal office can determine forest ownership only for new owners. As stated in the amendment of May 2016, the new registry system aims to combine all of this information, which was separately managed, into a new registry managed by the municipal office. In addition, a forest land map system was added to the 2016 amendment.

In addition, the Forestry Agency hopes to use this new registry to promote intensive forest practices. The Forestry Agency plans to introduce this registry during 2016–2018. The creation of the forest land registry is the first countermeasure to combat the increase in the number of forests with unknown owners and/or boundaries. This is just the beginning of a series of policies targeting unknown forest owners.

Several difficulties are anticipated with the creation of a forest land registry. In particular, aging owners will be difficult to address. In some villages, there are no inhabitants who are able to access their forest, which is precipitating the loss of information on boundaries held in the memories of elderly forest owners. In addition, there is minimal or no dependence on forest product sales as an income source, thereby decreasing interest in caring for the forests. Moreover, the number of non-villager and/or non-farmer forest owners is increasing. These are both anticipated difficulties that the new registry aims to address.

Although these conditions are strictly related to forest owners, there is an additional issue related to the administrative sector, referred to as the vertically segmented administrative system. The 2016 amendment allows for information from the land regis-

try and non-national forest resource database to be combined; however, information derived from fixed asset tax rolls is not included (Ueda, 2016). Even in cases where no villagers or local forestry related organizations know the legal forest land owner, the new forest owner must pay taxes, including the fixed asset tax and/or inheritance tax; therefore, the taxation office has records of the legal forest land owner and has a land registry used only for the purpose of taxation. The use of this registry for purposes other than services related to taxation is highly restricted. However, some municipal offices may have no choice, but to depend on the taxation registry. Because the new forest land registry was introduced only in May 2016, future research will need to examine this issue in relation to the management problems of forests with unknown owners and/or boundaries.

Finally, based on Census results, the number of private forest owners is decreasing. As explained above, the Census survey method changed completely after the 2005 survey; therefore, the most recent Census that included all forest owners with forests over the minimum holding size, i.e., 0.1 ha and 1 ha before 1990 and in 2000, respectively, was the 2000 survey. After 2005, the number of private forest owners who owned areas larger than 1 ha was determined for the purpose of selecting on-site survey forest owners in the new Census. Notably, the purpose of surveying the number of forest owners with areas larger than 1 ha differed before 2000 and after 2005. In 2000 and 2015, 1,018,752 and 828,973 people owned forests larger than 1 ha, respectively, representing a decrease of 18.6% over 15 years. Although these figures must be carefully interpreted, these data suggest that some private forest owners sold their forests. The proportion of forest owners with holding sizes of 1–5 ha, 5–10 ha, 10–20 ha, 20–30 ha, 30–50 ha, 50–100 ha, 100-500 ha, and ≥ 500 ha were 81.0%, 79.5%, 83.3%, 88.5%, 85.6%, 89.0%, 120.6%, and 130.3%, respectively. Notably, the number of forest owners with holding sizes less than 100 ha decreased, while those with holding sizes greater than 100 ha increased. This indicates that relatively small-scale forest owners started selling forests, possibly for the reasons discussed earlier in this section. However, this data must be analyzed carefully, and future research should conduct more detailed statistical analyses to clarify the changes in the number of forest owners.

6. Conclusion

We analyzed the characteristics of forest owners' households, limited to householders who engaged in both agriculture and forestry. It was found that the percentage of planting and timber production was low in one-person households. According to the Population Census, the total population reached a peak in 2010 and, recently, household sizes have decreased, such that the percentage of one-person households increased to 32.4% of the total in 2010. These results mean that the percentage of forestry households with low timber production is increasing. In 2000, the peak householder age was in the 65–69 years age class, which provides statistical verification that in 2000

private forests were mainly owned and managed by elderly people. The possibility of peak ages was suggested for forest practices and timber sales. The peak ages of timber production and planting were in the 60–64 and 70–74 years age classes, respectively. It is likely that the peak age of forest householders will increase to exceed the peak age of forest practices and timber production.

Although household size and age were taken as independent factors in this analysis, elderly one-person households are facing the most difficult situation. Even in the case of elderly owners in their 80's, there are no forest management concerns when the younger successor is living in the same household. In the case of a one-person household consisting of a young man, possibilities for future forest management may be expected. A more detailed analysis is necessary to clarify the characteristics of forest management activities by elderly people aged 75 years and above, and to understand why the percentage of forest practices and timber production decreases in one-person households. This should be accompanied by an on-site survey.

In this analysis, household size and householder age were the only two variables considered. Other characteristics related to forest owners' households should be analyzed, such as sex, generations, importance of agricultural income, inheritor, etc. Regional differences are also important. For example, in the Hokkaido, Shikoku and Chugoku regions, where an increase in uninhabited villages is expected, the situation will be more serious than in this analysis based on the whole of Japan. Although the current Census started in 2005 includes very few surveyed households, a method for using current survey data and connecting it to the 2000 survey should be devised.

Finally, Japanese population characteristics should be analyzed in detail in the context of an international research framework. Japan reached a peak population in 2010, after which the population decreased. According to World Population Prospects[12], 13 countries experienced a total population decrease of over 100,000 between 2010–2015, which are, in order of the decrease in population; Syrian Arab Republic, Ukraine, Romania, Japan, Spain, Bulgaria, Georgia, Lithuania, Portugal, Greece, Serbia, Hungary and Latvia. Hence, Japan is situated among South and East European countries in terms of experiencing population decline between 2010–2015. The diminishment of households and aging were found to influence timber production in this analysis; is this unique to Japan? Are there any social factors or policy problems seen in Japan in particular that exacerbate the aging problem? Analysis by means of international comparison is an essential research topic for the future.

Acknowledgments

Part of this study was presented at the 2015 Japanese Joint Statistical Meeting held at Okayama University, Japan, the 66th Annual Meeting of the Society of Applied Fo-

[12] United Nations: World Population Prospects: The 2015 Revision, https://esa.un.org/unpd/wpp/Download/Standard/Population/, 2016/06/24

rest Science held at Okayama University, Japan, in 2015, and the IUFRO (International Union of Forest Research Organization) Symposium (Unit 4.05.00, Managerial Economics and Accounting) held at the University of Natural Resources and Life Sciences Vienna (BOKU), Vienna, Austria, in 2016. We would like to express our gratitude for all the comments made at these meetings. The research using the data from the 2000 World Census of Agriculture and Forestry was conducted as part of a research project at the Laboratory of Statistical Digital Archives of Agriculture, Forestry, and Fisheries, Graduate School of Agriculture, Kyoto University. We also thank the staff of the Statistics Department of the Ministry of Agriculture, Forestry and Fisheries, of the Japanese Government.

References

Cabinet Office (2015) Korei shakai hakusyo (White paper on aging society), fiscal 2015, Cabinet Office, Tokyo, Japan. (in Japanese)

Forestry Agency (1995) Ringyo tokei yoran (Annual statistics of forestry), 1995 ed., Rinya Kosaikai, Tokyo, Japan. (in Japanese)

Forestry Agency (2002) Ringyo tokei yoran (Annual statistics of forestry), 2002 ed., Rinya Kosaikai, Tokyo, Japan. (in Japanese)

Forestry Agency (2015) Shinrin ringyo tokei yoran (Annual statistics of forest and forestry), 2015 ed., Nihon Shinrin Ringyo Shinkokai, Tokyo, Japan. (in Japanese)

Forestry Agency (2016) Shinrin ringyo hakusyo (White paper on forests and forestry) 2016 ed., Zenkoku Ringyo Kairyo Fukyu Kyokai, Tokyo, Japan. (in Japanese)

Kohroki, K. (2009) Kazoku ringyo keieitai no keiei kiban to seisan katsudo (Management foundation and production activities of farm forestry), In: Mochida, H. and Shiga, K. eds, Nihon ringyo no kozo henka to census taikei no saihen, 2005 nen ringyo census bunseki (Structural changes in Japanese forestry and restructuring the census survey method, analysis of the 2000 Forestry Census), pp. 60–100, Norin Tokei Kyokai, Tokyo, Japan. (in Japanese)

Kono, S. (2007) Jinkogaku heno syotai: shoshi koreika wa dokomade kaimei saretaka (Introduction to demography: to what extent the low birth rate and an aging population were solved?), Chuko Shinsho, No. 1910, ChuoKoron Shinsha, Tokyo, Japan. (in Japanese)

Hayrinen, L., Mattila, O., Berghall, S. and Toppinen, A. (2015) Forest owners' socio-demographic characteristics as predictors of customer value: evidence from Finland, Small-scale Forestry, 14:19–37.

MAFF (Ministry of Agriculture, Forestry and Fisheries) (2015) Shinrin shigen no jyunkan riyou ni kansuru ishiki iko chosa (Survey of consciousness and intention on sustainable utilization of forest resources), Statistics of Agriculture, Forestry and Fisheries, http://www.maff.go.jp/j/finding/mind/pdf/sinrin_27.pdf, 2016/07/17 (in Japanese)

MAFF (Ministry of Agriculture, Forestry and Fisheries) (2016) 2015 nen noringyo census kekka no gaiyo, kakuteichi, 2016/02/01 (Summary of result of 2015 World Census

of Agriculture and Forestry, definite value, as of February 1 of 2016), Statistics of Agriculture, Forestry and Fisheries, corrected value of April 27 of 2016, http://www.maff.go.jp/j/tokei/census/afc/2015/pdf/census_15k_20160427.pdf, 2016/07/16 (in Japanese)

Masuda, H. (2014) Chiho syometsu: tokyo ikkyoku syutyu ga maneku jinko kyugen (Rural disappearance: rapid decrease in total population caused by excessive concentration of population and industry in the Tokyo Metropolitan area), Chuko Shinsho, No. 2282, Chuokoron Shinsha, Tokyo, Japan. (in Japanese)

Matsushita, K. (2015) Japanese Forestation Policies During the 20 Years Following World War II, In: Miodrag Zlatic ed., Precious Forests: Precious Earth, pp. 83–112, InTech, Rijeka, Croatia.

Matsushita, K. and Yoshida, S. (1998) Private forest owners and the forest resource database, Journal of Forest Planning, 4(2):53–63.

Meadows, D. H. (1972) The limits to growth: a report for The Club of Rome's project on the predicament of mankind, Universe Books, New York.

MHLW (Ministry of Health, Labor and Welfare) (2015), Heisei 26 nen kanni seimeihyo no gaiyo (Abstract of simple life table in 2014 in Japan), http://www.mhlw.go.jp/toukei/saikin/hw/life/life14/dl/life14-15.pdf, 2016/06/28 (in Japanese)

MIC (Ministry of Internal Affairs and Communications) (2011) Kaso chiiki ni okeru syuraku no jyokyo ni kansuru genjyo haaku chosa kekka no gaiyo (Abstract of the result of a survey on the current situation of hamlets in depopulated areas, etc.), http://www.soumu.go.jp/main_content/000112719.pdf, p. 16, 2016/07/17 (in Japanese)

MIC (Ministry of Internal Affairs and Communications) (2016) Heisei 27 nen kokusehi chosa jinkou sokuhou syukei kekka youyaku (Summary of preliminary report of 2015 Population Census), http://www.stat.go.jp/data/kokusei/2015/kekka/pdf/youyaku.pdf, 2016/06/22 (in Japanese)

MLIT (Ministry of Land, Infrastructure, Transport and Tourism) (2011) http://www.mlit.go.jp/common/000135838.pdf, 2016/06/30 (in Japanese)

MLIT (Ministry of Land, Infrastructure, Transport and Tourism) (2016) Website on cadastral survey, http://www.chiseki.go.jp/situation/status/index.html, 2016/06/23 (in Japanese)

Nagata, S. and Hayashi, U. (1991) An essay on forecasting labor force in forestry: A cohort analysis on forestry workers using national census data, Journal of the Japanese Forestry Society, 73(1):50–53. (in Japanese)

National Institute of Population and Social Security Research (2013) Nihon no shyorai suikei jinko: Heisei 24 nen suikei no kaisetsu oyobi sanko suikei, jyoken tsuki suikei (Population projections for Japan: a supplement to the 2012 revision, commentary with ancillary projections), Population Research Series, No. 327, Table A-8, pp. 79–80. http://www.ipss.go.jp/syoushika/bunken/data/pdf/207993.pdf, 2016/06/30 (in Japanese)

Sato, N. and Macel, P. (2006) Attitudes of small-scale forest owners to their properties in an ageing society: findings of survey in Yamaguchi Prefecture, Japan, Small-scale Forest Economics, Management and Policy, 5(1):97–110.

Sato, N. (2009) Kazoku ringyo keiei setai no jittai to sono jizoku kanousei (Actual con-

dition and sustainability of household of family forest management entities), In: Mochida, H. and Shiga, K. eds, Nihon ringyo no kozou henka to census taikei no saihen (Structural changes in Japanese forestry and restructuring the census survey method, analysis of the 2000 Forestry Census), pp.101–114, Norin Tokei Kyokai, Tokyo, Japan. (in Japanese)

Sato, N. (2013) Kazoku ringyo keieitai no nogyo kozo oyobi noringyo keieitai ni yoru sozai seisan no jittai (Agricultural structure of farm forestry and log production by agricultural and forestry management entities), In: Kohroki, K. ed., Nihon ringyo no kozo henka to ringyo keieitai, 2010 nen ringyo census bunseki (Structural change in Japanese forestry, analysis of 2010 Forestry Census), pp.109–134, Norin Tokei Kyokai, Tokyo, Japan. (in Japanese)

Shiga, K. (2002) Sanrin hoyu to shinrin keiei, ringyo jigyotai chosa no bunseki, Mochida, H. ed., Nihon ringyo no kozo henka to saihen katei, 2000 nen ringyo census bunseki (Structural changes and restructuring of Japanese forestry: analysis of 2000 forestry census), pp. 82–155, Norin Tokei Kyokai, Tokyo, Japan. (in Japanese)

Statistics Bureau, MIC (Ministry of Internal Affairs and Communications) (2005). http://www.stat.go.jp/data/topics/topi141.htm, 2016/06/26 (in Japanese)

Statistics Bureau, MIC (Ministry of Internal Affairs and Communications) (2016), http://www.stat.go.jp/data/jinsui/pdf/201606.pdf, 2016/06/20 (in Japanese)

Ueda, G. (2016) Touki jyoho wo motiita syoyusha fumei shinrin chousa nit suite (On the survey of forests where the owner is unknown using land register information), Kaihou (Shinrin Keikaku Kenkyukai), No. 462:22–27. (in Japanese)