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Analysis of the Mechanism Hindering Sustainable Forestry Operations: A Case Study of Japanese Forest Management

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Abstract: We investigated local forest management practices in Osaka, Japan aiming to clarify mechanisms that hinder long-term, sustainable forestry operation by carrying out forest surveys and interview surveys. Because mountain districts in Japan now face declining and aging populations, forestry work has shifted to forest owners' associations, with efficient forest management being required on an ad hoc basis as a result of the subsidy system. We found that the forest management plan for the study site utilized only one-seventh of the economic value of the forest, mainly due to the local forestry structure and an inefficient subsidy system that requires efficiency. The income yielded by timber undergoing such forest management and distribution processes is too low to permit forest owners to carry out sufficient forest cultivation. To effectively utilize the wood, a subsidy system that takes a long-term view and a timber market that puts an appropriate price on wood are needed. We argue that it is important to bolster the management position of the Japanese Forest Owners' Associations for design an institutional scheme that enables to practice forestry management from a long-term perspective.

Keywords: economic viability; sustainability; subsidy; small scale forestry; forest owners' association

1. Introduction

Demand for timber in Japan rose steeply after the Second World War as a result of the massive nationwide reconstruction effort, and a large number of conifers were planted. However, due to increasing competition from foreign timber and decreasing overall demand, the value of domestic timber peaked in the early 1980s and began declining thereafter [1–3]. Currently, the timber self-sufficiency rate in Japan is only about 30%, although the Japanese government has implemented measures to support forestry [4]. At present, the domestic forestry industry is highly dependent on national and local government subsidies [5,6]. Because the amount and purpose of use is limited by the management policy depending on the country's situation, it is difficult to create a management plan from a long-term perspective. Consequently, forest management is now practiced with an emphasis on immediate profitability, and not enough attention is paid to its sustainable management. The sustainability of forest management is based primarily on the amount of carbon storage and environmental loads such as CO_2 emissions [7]. Japanese forestry research has now begun to re-evaluate forestry from economic and silvicultural perspectives. Such studies include, but are not limited to, those related to the wood distribution [8,9], stand volume growth [10,11], and profitability and efficiency of forestry [12,13]. In Mountain districts, young people flow out into cities, while the number of absentee

forest owners is simultaneously increasing. Given this background, developing a vision of sustainable forestry that takes a number of different factors, including socio-economic aspects and environmental loads associated with forestry into consideration will be indispensable. To that end, it is necessary to have a comprehensive understanding of the current state of forestry in the mountain districts of Japan and to propose concrete, implementable forestry reforms [14].

Such problems regarding forestry are found in Japan as well in other countries. However, in Japanese forestry, there are special circumstances. First, there is a contradiction in the fact that Japan relies on imported materials for 70% of the wood used in the country, even though forests account for 70% of the country's area. For example, in terms of the amount of imported pulp (years 1992–2014), Japan is ranked third in the world, following the United States and Canada [15]. However, the timber self-sufficiency rate is high, 86% in United States and 303% in Canada [16]. Thus, the Japanese distribution system of domestic timber is not properly developed. In addition, in Japan, there are many steep mountainous areas that make it difficult to carry out large-scale forestry projects such as in the United States and Canada. As a result, collective forest management by the Forest Owner's Association is commonly found. Meanwhile, population decline and aging in rural areas can be seen in many industrialized countries [17]. However, the impact of these demographic trends is probably small for industrialized Western forestry while it is considered to be large for Japanese forestry because forest owners themselves are aging [18]. In other words, there are two requirements for forest management in Japan: FOA oversight and subsidy assistance. It can be said that the discussions in this paper have important implications for both undertakings of "effective use of domestic resources" and "activation of the regional economy."

Forest owners' associations (FOAs) in Japan are cooperatives formed by forest owners to manage forests. These organizations have important role to play under the circumstances currently facing the Japanese forestry industry. These associations are established under the Forestry Cooperative Act of 1978 [19]. It is the present circumstances faced by Japan's mountain districts that populations are simultaneously declining and aging, as a result, the burden of forestry work has shifted to FOAs and collective forest management has become common. Although sustainable forest management is required now, basic management policy is on an ad hoc basis because of the lack of subsidies for forest management. Further, it can be seen that the subsidy system operated by the government in Japan is not necessarily designed to match the specific characteristics and structure of all local forestry [20]. Because the amount and purpose of use is limited by the management policy depending on the country's situation, it is difficult to create a management plan from a long-term perspective. Up to the present, efficient forest management with an emphasis only on profitability has been required. If there are no extra funds, it is difficult to set up management plans for felling cycles, selective logging and forest road maintenance that are, for example, environmentally sound. For example, in deep mountains, even if there are trees of optimal age for use, logging is not carried out because of the cost and effort. In addition, similar difficulties are involved in the removal of thinned wood, and as a consequence it is often left in the forest as residual wood. In order to conduct businesses of a low profitability with a small budget and personnel, the degree of efficiency in attaining a profit is of critical importance. Consequently, at present, it is not possible to practice sustainable forest operations based on the long-term perspective that is actually required. This may has led to a deterioration of forest resources. In order to overcome these challenges, FOAs must develop schemes for realizing long-term collective forest management.

Studies of the history of FOAs [21,22] and Current conditions and challenges of FOA management [23,24] exist. However, none have yet delved into the actual mechanisms that hinder long-term collective forestry management in Japan, particularly from the viewpoint of the relationship between local forest management (FOAs) and the subsidy system. This paper carried out as a case study of local forestry in Osaka Prefecture, Japan and the associated Osaka Prefecture FOA (OFOA). The objectives of the study are to investigate the structure and mechanisms involved in present local forestry in Japan. The study analyzes forestry planning and operation from socio-economic standpoints

and identifies ways to promote utilization of forest resources in Osaka Prefecture. The paper takes holistic approach looking into the following points of the case study area: the timber distribution system, historical changes in forestry management, the flow of funds, the relationships between stakeholders and the economic viability of the forest management plan. We hypothesized that such holistic approach may provide us with a clue to systematically understand why sustainable forest operations based on a long-term perspective are hindered. This study indeed brings important implications for forest management in other countries. Many developing countries have not established individual ownership of forests and the number of small-scale forest owners is limited. However, as economic development advances, OAs (owners associations) might emerge in agriculture and forestry. Therefore, these situations of the FOAs in Japan can serve as case study when considering policies for sustainable forest management.

The remainder of this paper is organized as follows. The next section briefly reviews the current state of Japanese forestry policies and explains the roles and significance of FOAs. The third section addresses the materials and methodology used for the case study in Takatsuki City, Osaka Prefecture, Japan. The forth section presents the results of our analysis, particularly in terms of the current status of forestry management in Nakahata District in Takatsuki City, and the estimated economic viability of the OFOA's forest management plans. Lastly, conclusions and policy implications follow.

2. A Review of the Current State of Japanese Forestry Policies and Function of FOAs

In Japan, a country where forests cover approximately 70% of the land area, forestry has been considered an important industry since ancient times. Japan experienced a building rush during the rapid growth period following the end of the Second World War. It was not possible to meet this rising demand solely with domestic timber so the trade in timber was liberalized beginning in 1961. Thereafter, the wood price of domestic timber declined due to competition from foreign imports such as China. Furthermore, recently, distribution and processing routes for foreign timber have become established, so that timber has become common in Japan.

Increasing the level of timber self-sufficiency has become an important policy target, and the forest planning system was drastically reformulated in a Fiscal Year (FY) 2011 revision of the Forest Act. This prompted the adoption of a new scheme, the "Forest Management Plan" [25]. The goal of the scheme is to conduct efficient forest thinning, adopt intensive forest management practices by establishing road networks and mechanizing much of the work (proposal-based intensive forest management). As of FY2012, the thinning subsidy system paid for the removal of 10 m^3/ha or more of conifer timber by thinning forests with contiguous areas of 5 ha or greater (collective management areas). However, there are problems with this system. The first is the limited scope of individuals who are eligible to receive the subsidy. The regulations stipulate that the system only applies to contiguous forests. This makes it difficult for small-scale forest owners who have less than 5 ha forest area to perform thinning themselves to qualify. That type of owner accounts for about 30% of all forest owners [26]. At the result, intensive forest management by the FOA has become common in Japan. The second problem is that the law has set a limit on the minimum amount of wood that can be removed from a site [27]. This tends to exclude less-profitable forests such as those on steeply sloping land or in remote mountainous areas. A further issue is that, the subsidy, which is paid using funds from the Forest Management and Environmental Conservation Direct Support System, is intended to promote only the removal of thinned timber. Recently, competition with foreign timber has become intense. Thus, thinning and pruning are needed to improve the quality of the wood. Thus, it cannot be used for pruning, which is necessary to produce superior-quality timber. Given the additional requirement related to the use of subsidies paid for by tax revenues to support privately owned forests, it is clear that the healthy cultivation of such forests is difficult in the current circumstances.

FOAs carry out various tasks including proposing and implementing forest management plans, purchasing machinery and materials, selling forestry products, providing investment financing, and nurturing the forestry workers. Depending on the region, they are organized by cities, towns,

districts or prefectures. One higher-level organization is the Prefectural Federation of Forest Owners Association, which falls under the National Federation of Forest Owners' Co-operative Association (JForest). In addition to the associations described above, there are production forest unions, which are organizations where forest owners pool their forest holdings and manage them jointly through a single organization. Production forest unions have also joined FOAs.

Shiga [21] claims that organizations that serve similar functions to FOAs in Europe can be divided into Scandinavian- and Western European-type organizations (both of which will be referred to using the term "FOA" hereinafter). Scandinavian-type FOAs are independent from the government and engage in all aspects of forestry, up to timber processing [28,29]. German FOAs, which are representative of Western European-type organizations, carry out their functions in cooperation with the government and receive direct support from the State. Japanese FOAs fall somewhere between the Scandinavian and Western European-type organizations [20,30]. In Germany, for example, which has an advanced forestry industry and is considered a model for the Japanese forestry industry to aspire to, there are forestry collective organizations called Forestbetriebsgemeinschaften (FBG). These are prescribed in the Federal Forest Act of Germany and are, for the most part, equivalent to FOAs in Japan. According to Hori et al. [30], the main functions of FBGs are timber sales, road construction, and shared machinery use. In contrast Japanese FOAs possess exclusive work parties or timber-processing facilities. USA and China also have forest cooperation systems [31–34]. Thus, organizations equivalent to Japan's FOAs in terms of enabling cooperative forestry management exist around the world, although their specific functions and structures vary.

3. The Study Site

This study looked into the case of the Mishima branch of the OFOA. The office of the Mishima branch of the OFOA is located in the north of Takatsuki City. The location of the study site is shown in Figure 1. The OFOA, which was formed in 2001 through the merger of 16 FOAs in Osaka Prefecture, possesses a joint timber sales facility (raw timber market). The OFOA operates its own wood market, a lumber mill, and a log processing plant, as well as a Forest Visitors Center and a Forest Resource Processing Center. Thus, the OFOA is engaged in not only forest management but also timber processing and the effective use of woody biomass and tourism. The forest resource processing center is located within the case study area, where branches, leaves and wood wastes are converted to bio-cokes and wood pellets. The wood from the OFOA forestry operations is used mainly, more than that from other local forestry areas. Therefore, looking into its operations could provide useful information about the benefits and merits of using local materials (wood) from forestry management and economic viability viewpoints.

The selected area within the study site is compartments 86 and 87, which has 50.1 ha forest area according to the forest register, located in Nakahata District of Takatsuki City in the OFOA's Mishima branch. In that area, we carried out forest inventory for the express purpose of analyzing the economic viability of the forestry there. According to forest registration data, the study site comprises 11.8 ha of Japanese cedar (*Cryptomeria japonica*), 6.46 ha of Japanese cypress (*Chamaecyparis obtusa*), and 31.8 ha of mixed Japanese cedar–cypress, all of which are privately owned, planted forests. The data also indicate that mean tree age in the study site is 47 years (53.3 years for the Japanese cedar, 42.5 years for Japanese cypress, and 46 years for mixed Japanese cedar-cypress stands). The optimal rotation age for forests in Osaka Prefecture is set at 40 years for Japanese cedar and 45 years for Japanese cypress [35], so it can be concluded that the study site forest is of an appropriate age for felling. It should be noted that the site was scheduled to be thinned by the Mishima branch of the OFOA starting in September 2013. The thinning intensity was set at 30%.

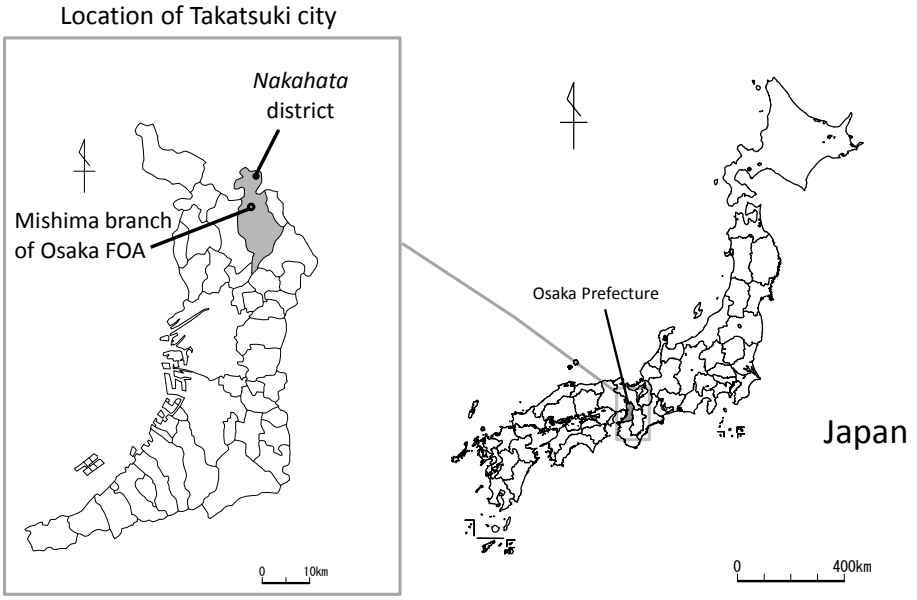

Figure 1. Overview of the study site overview.

4. Research Method

In order to clarify how FOAs functions fit into community forestry, an interview survey, forest survey, and a materials analysis were conducted. Firstly, a forest survey and material analysis was conducted to estimate the amount of forest biomass. Secondly, an interview survey to OFOA was carried out in order to understand the financial information of forest management; Thirdly, series of interview was demonstrated to reveal, the relationship among stakeholder, forestry organizational structure and money flow. Finally, an economic analysis was carried out in order to evaluate Japan's forestry system objectively. These analyses provide the important information to grasp the domestic wood distribution as a system and to understand the current situation of low timber self-sufficiency rate.

4.1. Understanding the Current Situation of OFOA

The study examined a forest stand in Nakahata District, where forest management was implemented by the OFOA in FY2013. We investigated about the current situation of OFOA by meeting with four persons in total from November 2013 to April 2014. Each interview lasted about one hour and two investigators joined as a questioner and a note-taker in each. After obtaining the interviewee's consent, the interviews were recorded.

In Nakahata District, inquiries plus relevant note-taking with the two persons were carried out: A is a male in his 60s who is a former employee of the Takatsuki municipal office and serves as the district manager, and B is a male in his 70s who works part-time for the forest association. At the OFOA, inquiries were made with C, a male in his 40s who is the director of the OFOA Mishima branch, and D, a male in his 60s who is an OFOA director. These interviewees are key people for the forestry there, providing not only specific information about forestry operation and management but also their own perspectives on the organizational status of Japanese forestry. The information gathered along with forest registers and document of the OFOA's 2013 forest management work plan served to identify the current status of forestry management by the OFOA making it possible to analyze the timber distribution system, forestry management changes, flow of funds, and relationships among stakeholders. By analyzing the information obtained, the relationship among the stakeholders was organized based on the supply and demand relationship in Figure 2, and money flow in Figure 3.

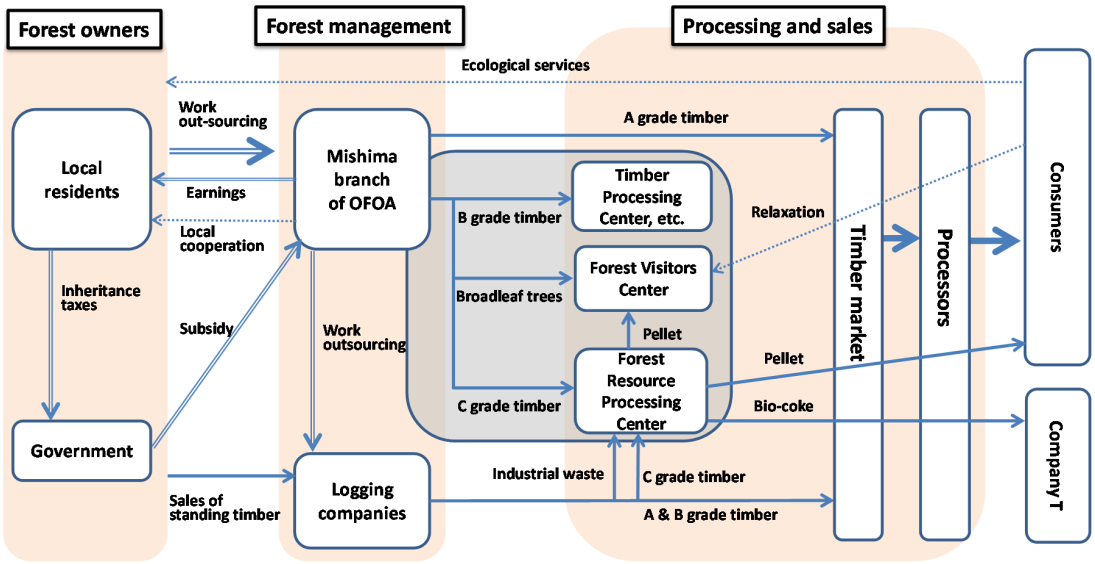

Figure 2. Current timber distribution scheme and relationships between stakeholders in the Nakahata District study site. Note: The figure was drawn by the authors based on field surveys. Straight arrows indicate timber distribution flow, double arrows indicate supply, and dotted arrows indicate requests.

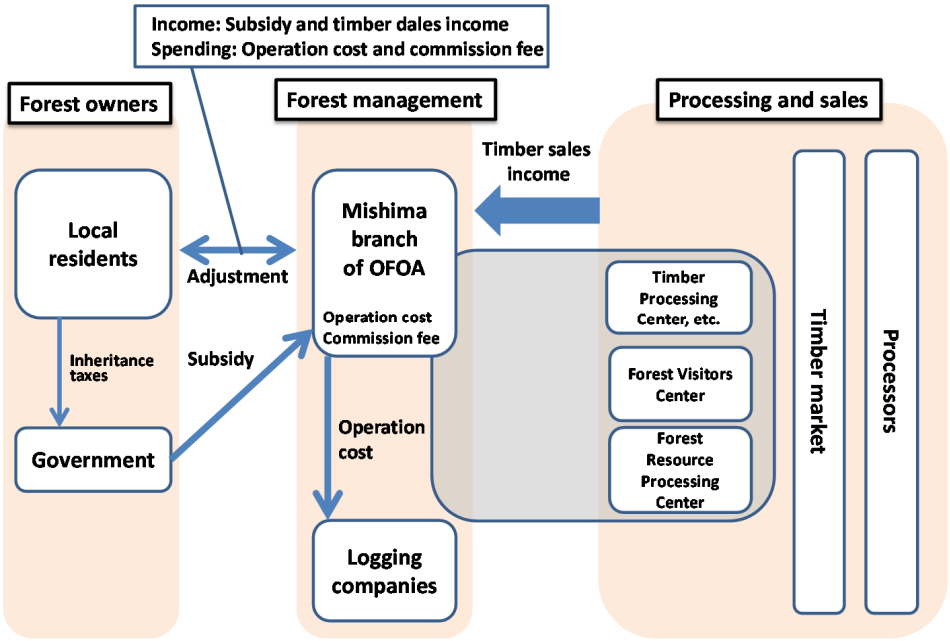

Figure 3. Financial flow within the Forest Owners Association. Note: The figure was drawn by the authors based on field surveys.

4.2. Survey of Forest

On 19 July 2013, individual tree surveys were conducted in three areas within the study site, which had been identified as exhibiting typical forest cover. After establishing 10 m × 10 m (horizontal distance) square sampling plot within each area randomly, the tree type, diameter at breast height (DBH), tree age, and number of trees were recorded for each sample area. The timber volume of the study site was calculated using the equations below, in which V is the volume of timber per hectare, H is tree height, and N is the number of trees per hectare. The equations are taken from the Forestry Agency's Planted Forest Stand Density Management Chart [36].

$$\text{Japanese cypress}: V = (0.0390819 \times H^{-1.147348} + 8524.5 \times H^{-3.102942}/N)^{-1}$$

$$\text{Japanese cedar}: V = (0.061977 \times H^{-1.351766} + 4725.2 \times H^{-2.823636}/N)^{-1}$$

The expected yield includes leaves, branches, and lumber remnants as well as saleable timber. Following the example of the Forestry Agency's estimated log market price table, a rough estimate of timber utilization amount was generated by assuming a timber utilization rate of 76% [37].

4.3. Economic Analysis

Based on the OFOA's 2013 forest management work plan for Nakahata District, the balance between the extent of felling and sales from an economic viewpoint was evaluated. In addition, revenue using two types prices for timber were estimated. For grade A timber, a price of 9389 JPY/m^3 was used, based on the mean price of raw timber from the Nakahata collective management area sold at the timber market between November 2012 and February 2013. These data were obtained from the OFOA interviews. For other timber grades, 8000 JPY/m^3 for grade B and 6500 JPY/m^3 for grade C timber were respectively assumed, based on actual FY2012 prices also obtained from OFOA interviews. This timber is used to make rods, pellets, and bio-cokes. Revenue for a mix of 57% grade A, 31% grade B, and 12% grade C timber was also estimated, based on actual sales of timber from the Nakahata collective management area between November 2012 and February 2013. For comparison, the forest management plan was used for the collective management area containing the study site. As explained earlier, the OFOA's total income assumes subsidies from Osaka Prefecture and Takatsuki City, as well as income from timber sales. However, here, the analysis will disregard the subsidies and compare the actual gross revenue from timber sales with the theoretical maximum revenue from the forest in question.

5. Results

5.1. Current Status and Structure of Forestry Management by the OFOA

Research findings are presented below on the timber distribution system, forestry management changes, flow of funds, and the relationships between stakeholders.

5.1.1. Timber Distribution System

Because the conditions set for subsidy acquisition involve removing at least a certain amount of material from an area no smaller than a set size, managers must generally obtain permission from multiple forest owners. To obtain consent from all the necessary forest owners, meetings are held to explain various aspects of a forest management plan, which can include logging road construction plans, thinning plans, timber sale arrangements, and earning distribution. However, since it is difficult to meet directly with all the forest owners, a large number of whom are absentee owners, it is sometimes necessary to enlist the help of district managers such as subject A.

Timber is generally classified into grades A, B, C, or D based on its quality (primarily warping and shape) and purpose. Grade A timber is good quality material used in construction, grade B timber is used to make laminated lumber or plywood, and grade C grade timber is used to make chipboard or wooden board. Grade D timber refers to residual thinnings and timber offcuts that are not normally removed. It is anticipated that some material can be used as fuel to produce woody biomass energy. Grade A timber is shipped to raw timber markets to be milled (Figure 2). With regard to forest management in Nakahata District, because the OFOA-owned raw timber market is relatively far away, timber is shipped to the closer timber market in Kyoto Prefecture. Kyoto Prefecture timber markets tend to assign lower prices to timber produced outside the prefecture than locally produced timber. B- to D-grade timber that is not high enough in quality to justify shipping to such markets is used to make rods (dowels), laminated lumber, or to produce woody biomass energy.

The Mishima branch is unique in that this timber is shipped to a timber-processing center where it is converted into pellets, bio-coke, and compost [38]. Currently, there are few facilities in Japan to refine wood material into bio-coke, and all the bio-coke produced by the Mishima branch is sent to auto manufacturer T, where it is used as a fossil fuel alternative. In addition to being sold in regular markets, pellets are used to fuel the hot-water heaters at the Forest Visitors Center. Timber from broadleaf trees generated during forest management implementation is also used at the Forest Visitors Center as a substrate for shiitake mushrooms and as raw material for charcoal. These are then used at the Forest Visitors Center for shiitake mushroom hunting events and by center visitors to char-grill or barbeque food. It can be seen that a forest management system has been established to efficiently use all the materials generated by implementing forest management plans.

5.1.2. Historical Changes in Forestry Management

In the 1980s, the majority of households in the Nakahata area engaged in agriculture with forestry as a secondary business. The parents of subjects A and B practiced forestry as their main livelihood. Their main roles in the forestry industry were forest ownership and management (planting, thinning, etc.). According to subject A, in the past timber was in demand from the Kansai Electric Power Company, to be used as utility poles, and from timber logging companies. In general, a certain number of trees were purchased while standing. The bark was removed in the summer, and the trees were felled in the winter. Immediately after the Second World War, there was substantial demand akin to that described above, and it was said that one could expect a stable life 50 years down the line if one planted trees. From the mid-1950s to the mid-1960s, both subject A's and subject B's households had charcoal kilns on their respective woodland properties and produced charcoal. Many of the forestry households and forest owners near them also engaged in agriculture in the summer and forestry and/or charcoal production in the winter as their main livelihoods. Then, import duty on foreign timber was abolished due to the excessive demand associated with the post-war reconstruction. As a result, importing foreign timbers became much easier and the timber self-sufficiency rate in Japan has gone down, as mentioned earlier. Although domestic timber has been defeated by foreign timber for this reason, the abolished import duties remain unchanged even now.

As a result, today, the income expected from forestry is no longer at a level that is relied upon as a business, as can be seen in Figure 2, which shows the current state of the practice. Overall, the practice of forestry in Japan has been turned over to FOAs due to various factors. These indicate, for example, declining timber prices, declining purchases of standing timber by logging companies due to declining demand, aging of forest owners, and a shortage of young people willing to move into the industry.

Furthermore, it should be noted that a significant number of mountain forests have absentee owners. In fact, of the 13 owners, including subject A, of compartments 86 and 87 in Nakahata District where FOA forest management was carried out in FY2013, half the land was held by absentee landowners. As subject A explains, "I cannot carry out forest management on my own, so my forest is just a negative asset for which I have to pay taxes. That said, I feel an obligation to hold onto it for future generations." This sentiment is widely shared by other forest owners who have no expectation of profiting from their forests. However, they maintain the hope that thinning and the construction of logging roads will have some positive effect, however small it may be, in the future.

Another big change seen in recent years is the diversification of ways in which timber is used. Up to now, conifer tree timber was primarily used as construction material, while the wood harvested from broadleaf trees in woodland areas was used as fuel or as substrate for cultivating mushrooms and other fungi. However, given the tide of environmental awareness of problems such as fossil fuel depletion and global warming, forests are expected to serve as potential sources of alternative carbon-neutral fuels [38].

5.1.3. The Flow of Revenue and Expenditure in Forestry

The income earned from forest management carried out by FOAs comes from sales of harvested timber and subsidies (Figure 3). Examination of the forest management work plan carried out for the Nakahata area mountain forests in 2013 reveals that subsidies received were approximately double the revenue from sales. FOAs' expenditures include the costs of carrying out forest management and the distribution of earnings to forest owners. In the past, forest owners were able to live off their forestry income, which included such FOA distributions. However, at present, the income distributed to forest owners through FOAs is lower than the cost of cultivating and maintaining the forests, making it difficult to rely solely on forestry as a livelihood.

Meanwhile, subsidies can, in certain cases, have a negative impact. According to workers at the timber Market, a thinking that it is not necessary to assign high prices to timber produced by FOAs because they already receive substantial subsidies has emerged in buyer. Another problem is that, the extent of business activities of the FOAs is influenced by the amount of subsidy which readily changes depending on political situations. However, processor needs to purchase a certain amount of woods on a regular basis based on their business plan. As the supply of foreign timber is stable, demand for foreign timber tends to increase.

5.2. Relationships between Stakeholders

This subsection examines the stakeholder relationships as shown in Figure 3. Among the various stakeholder relationships, the focus was put on five main relationships, the ties between five kinds of stakeholders and the FOAs. These are the forest owners who are local residents in Nakahata District, the government, logging companies, businesses, and consumers. Note that although the government is also a forest owner, it was focused on its role as a source of subsidies.

5.2.1. Local Residents Who Are Forest Owners

On paper, local residents who are forest owners contract with FOAs to perform forest management. However, due to several factors including the advanced age and small number of local residents, the forest owners are, in reality, completely reliant on the FOAs. It should be noted that the charcoal kiln at the Forest Visitors Center was built by subject B, who is originally from Nakahata District and is a part-time employee at the Visitors Center. His knowledge of charcoal kiln building, acquired by helping his parents' generation produce charcoal, was used in creating the kiln.

5.2.2. Government

Forest management is performed in response to existing government policy and subsidies. In addition to contracting with FOAs to perform forest management in public forests, the government pays for this forest management while also providing subsidies to forest owners for thinning work as part of the direct support system. These support payments enable forestry to exist in its present form.

5.2.3. Logging Companies

Although FOAs enjoy the trust of local residents as quasi-public entities, they do not directly employ sufficient numbers of workers to perform all aspects of forest management. Accordingly, FOAs sometimes outsource a portion of the work to general logging companies. Since general logging companies are able to undertake work without needing to negotiate directly with the mountain forest owners, and without the paperwork burden related to applying for government subsidies, it is a beneficial relationship for the logging companies.

5.2.4. Businesses

The bio-coke manufactured by the OFOA is used by auto manufacturer T as a fossil fuel alternative in part of its manufacturing processing, allowing the company to reduce its environmental loading in

terms of CO_2 emission. The use of bio-coke helps fulfill its environmental obligations, in addition to helping improve its public image. At the same time, the manufacture of bio-coke enables the OFOA to maintain a system that does not leave lumber remnants unused. That said, because the price of coal is relatively low at the moment, company T spends slightly more on bio-coke than it would for an equivalent amount of coal. Unfortunately, as it would be difficult to lower the price of bio-coke given the manufacturing costs, the OFOA has no choice but to ask company T to pay a certain price. There is also the problem that currently company T is the only customer for the bio-coke.

5.2.5. Consumers

Although consumers seek high-quality goods at low prices, they also expect forests (forest owners) to provide ecological services. In other words, even though consumers prefer not to spend much money on goods that utilize woody biomass, they also make the contradictory demand that the forests themselves be appropriately managed.

5.3. Economic Viability of Forest Management Plans

5.3.1. Forest Condition Overview and Timber Volume of Each Vegetation Type

The forest vegetation revealed by the individual tree surveys is as follows: Plot 1 is a 40-year-old Japanese cypress stand with a mean tree height of 15 m and mean DBH of 21.7 cm. Plot 2 is a 47-year-old Japanese cedar stand with a mean tree height of 23.1 m and mean DBH of 30.1 cm. Plot 3 is a 43-year-old Japanese cedar stand with a mean tree height of 15.2 m and mean DBH of 20.5 cm. Plot 1 is located in the middle of a slope, while Plot 2 is located in a sunken area of a slope, and Plot 3 is located on a ridge.

The timber volumes calculated were 314.93 m^3/ha for Plot 1 (Japanese cypress), 574.3 m^3/ha for Plot 2 (Japanese cedar), and 304.13 m^3/ha for Plot 3 (Japanese cypress). The estimated harvest volumes based on the number of trees and assuming a thinning intensity of 30% were 94.48 m^3/ha for Plot 1, 172.29 m^3/ha for Plot 2, and 91.24 m^3/ha for Plot 3. This paper, based on these estimated harvests, assumes mean harvests of 172.3 m^3/ha for Japanese cedar, 92.9 m^3/ha for Japanese cypress, and 132.6 m^3/ha for mixed Japanese cedar-cypress. Applying these values to the areas occupied by each stand type (Japanese cedar, 11.8 ha; Japanese cypress, 6.47 ha; and mixed Japanese cedar-cypress, 31.8 ha) gives an expected yield estimate of 6849 m^3. Furthermore, assuming a utilization rate of 76%, the volume of usable timber is roughly 5205.7 m^3 (Table 1).

Table 1. Timber volume of each vegetation type.

Vegetation	Area (ha)	Harvestable Timber Volume (m^3/ha)	Expected Yield (m^3)	Actual Amount of Use (m^3)
Cedar forest	11.8	172.3	2033.0	1545.1
Cypress forest	6.46	92.9	600.8	456.6
Mixed forest	31.8	132.6	4215.8	3204.0
Total	50.06	-	6849.6	5205.7

5.3.2. Yield and Approximate Profits

This subsection calculates approximate income based on the expected harvest proposed by the forest management plan and on the expected yield. According to the OFOA's forest management plan, the expected timber harvest volume is 900 m^3, of which 500 m^3 will be sold to make rods and 400 m^3 will be sold to make wood pellets and bio-coke. The resulting estimated income from raw timber sales is 6.6 million JPY. This is designated as Result A (Table 2). Next, rough income estimates based on the expected yield is as follows. When assuming 57% grade A, 31% grade B, and 12% grade C timber, the gross revenue from raw timber sales is estimated to be 44,799,942 JPY (Table 2). These calculations indicate that, assuming a thinning intensity of 30%, this forest could yield 5205.7 m^3 of timber worth

44,799,942 JPY. In contrast, the same figures based on the OFOA's forest management plan are 900 m^3 of timber worth 6,600,000 JPY. In other words, the forest management plan captures only one-seventh of the estimated economic value of the study forest. There are many reasons for the amount of logging to be set to such an extent. For example, there is a possibility that the unit price will be lower when the amount of wood on the market surges. In addition, there is no guarantee that the current situations regarding subsidies, wood prices and demand will be maintained in the long term. In other words, it is difficult for the FOAs to decide to add workers in order to increase the harvest volume.

Table 2. Estimate of profit and yield.

		Forest Management Plan		Expected Harvest	
Product	**Unit of Price (Yen/m^3)**	**Actual Amount of Use (m^3)**	**Result A (Yen)**	**Actual Amount of Use (m^3)**	**Result B (Yen)**
Building material	9389	0.0	0	2964.1	27,830,282
Pile	8000	500.0	4,000,000	1599.7	12,797,325
Wood pellets and bio-coke	6500	400.0	2,600,000	641.9	4,172,336
Total		900.0	6,600,000	5205.7	44,799,942

As Tietenberg and Lewis [39] discuss in regard to efficient sustained yield, work plans must not be developed from the standpoint of cost performance. It is also important to keep future sustainability in mind. Benefits, costs, and quantity of effort all are related in the manner shown in Figure 4. E1 represents the optimal work balance that yields the maximum net revenue, which is calculated by subtracting costs from gross revenue. If the goal is economic profit, it will be necessary to adjust the amount of work to near E1. E2 is called the maximum sustainable yield and represents the point at which forest resources are maximally utilized in a manner that does not reduce them. E3 represents the point of maximum harvest. However, because harvest costs also increase, the sustainability of that point is low from an economic standpoint. If, on the other hand, economic considerations are ignored and the goal is to maximize forest maintenance, it is possible to perform work up to point E3 without having a deficit. There is, however, a risk that the forest resources will become depleted if there is any change in their growth rate. As such, it can be said that long-term utilization of forest resources at E1 levels is desirable from both forest and business management perspectives. That said, if there is a social demand to better prevent forest disasters (Landslide prevention and Soil retention), E2 becomes a viable option as well. It is believed that in the forest area managed by the OFOA, it is believed that forest management is done close to the level of E1. As mentioned above, that is a result of the relationship between supply and demand. On the other hand, when thinking about the entire Japanese forestry, that perhaps lies to the left of E1. This is because the number of forest workers and subsidies is insufficient and there are many untouched forests in Japan.

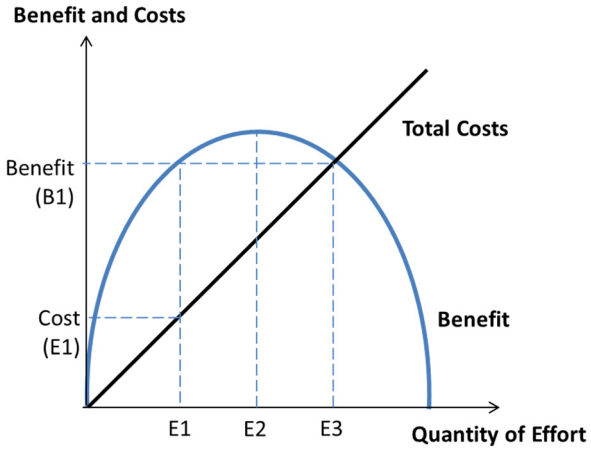

Figure 4. Efficient sustainable yield (Based on Tietenberg and Lewis, [39])

6. Discussion

6.1. Situation of Japanese Forestry

Our analyses identified two problems: "instability of the subsidies and policy" and "low evaluation of the domestic timber". In Japan, there are many steep mountainous areas that make it difficult to carry out large-scale forestry projects which are implemented in other countries. It is also difficult to create a management plan from a long-term perspective, because the amount and purpose of use is limited by the management policy depending on the country's situation. As a result, it had allowed the share of foreign timber that is possible to be mass distribution. For example, the analysis of an OFOA forest management plan from a production volume and economic standpoint revealed that the plan utilized only about one-seventh of the economic value of the forest in question. At present, the practice of forestry management is substantially influenced by subsidies, but these systems are changed frequently by government policies from time to time. This inevitably results in employment instability, which in turn, makes it difficult to take bold steps to expand business activities. The income from forests undergoing such management and distribution processes is too low to permit forest owners to carry out sufficient forest cultivation. Consequently, the number of forest workers declined, which eventually led to the limited amount of timber production by the FOAs. Nonetheless, consumers of timber products demand, first and foremost, low prices, while at the same time expecting forests (forest owners) to provide ecological services. Furthermore, most companies have a general management policy aimed at keeping the price of raw materials as low as possible. As such, even if such companies participate in environmental conservation activities such as tree planting, they are unlikely to voluntarily choose to purchase timber materials at higher than necessary prices.

Although both national and local governments currently find themselves in harsh financial circumstances, they have a valid interest in providing subsidies to systems that provide a minimum level of landslide protection. For their part, forest owners continue to hold their properties with no expectation of profit while bearing the burden of fixed property and inheritance taxes for the sake of passing forests down to future generations in good condition. This situation, in which governments, forest owners, and timber product manufacturers are deadlocked in circumstances that are difficult for all three parties represent an accurate appraisal of the current state of the forestry industry in Japan. We argue that the FOAs are important players in solving deadlocks because they are the only institutions that can coordinate forest owners, industry, and local/central governments. Considering the current economic performance of OFOA, improving their business management can considerably enhance the coordination capacity. In fact, our analyses revealed that the forest management plan captures only one-seventh of the estimated economic value of the forest and so there is a large room for increasing their profits without subsidies.

6.2. Policy Implication

Japan forestry is currently in decline, but the level of timber self-sufficiency has begun to rise gradually. This is the result of laws establishing timber points, certification systems, the promotion of timber use in public buildings and efforts to promote the use of woody biomass energy rather than the impact of subsidies for forest management. This study revealed implications about two measures necessary to further improve the timber self-sufficiency rate and revive the domestic forestry. The first is to establish a subsidy system from a long-term point of view aimed at reducing the instability of Japan's forestry policy (e.g., the frequently changing subsidy system). Particularly, with the poor business performance of FOAs, it is important to ensure the provision of sufficient and stable subsidies to both logging and silviculture (thinning and pruning). This is essential for sustainable forest management. The second is to create and maintain wood markets where it is possible to circulate local wood at an appropriate price to increase the value of domestic timber and promote effective use of wood.

For this purpose, it is necessary to reconsider the central role FOAs play in local forestry. In fact, FOAs lead the forest management and wood supply efforts in the region. As revealed by our survey, forest management is entirely dependent on subsidies and the actual work is dependent on the FOAs. Under the circumstances mountain districts currently face, FOAs will remain the primary implementers of community forestry, and it is necessary to create an environment in which they can proactively engage in community forestry.

We propose that the management status of the FOAs, which are responsible for the actual execution of forestry management, be bolstered. An adjustment will be necessary to increase the share of domestic timber in domestic markets and to be able to respond quickly to globalization. Now, 70% of the wood used domestically is from foreign production. There is a need of several decades to produce high-quality wood that can compete with foreign-produced wood, because proper management from the stage of afforestation and silviculture must be done. It is also essential to revise the plan every year in consideration of environmental impacts and political situation, in order to produce the high-quality products constantly. In the future, it will be necessary to determine the degree to which the FOAs forest-management plans exploit forest resources and to reassess these plans on a continual basis to ensure that the level of use is appropriate. However, FOAs are currently responsible solely for carrying out forest management and have no mandate to produce superior quality, high value-added timber. As described earlier, at present, forest management is only carried out to qualify for subsidies, and forest operations do not consider mid- or long-term perspectives. As such, there is a need to design a scheme in which FOAs can undertake collective forest management from a long-term perspective.

7. Conclusions

In this paper, we analyzed the role of Japanese FOAs and the effects of subsidies. It is not possible to continue providing subsidies to the forestry industry under the pretense of forest management. In other words, if forestry in Japan cannot stand on its own as an industry, it will not be possible to sustainably carry out appropriate forest management and thereby support the sustainable livelihoods of local residents. Unlike Western countries, Japanese forestry is characterized by is of a small- to medium-scale management. Thus, this model can be a good reference for the small-scale forestry and sustainable forest management in developing countries. Finally, this paper paid little attention to individual forest owners and industry, another important player in forestry. Understanding their situations will be necessary for specific policy and market design.

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