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Supply Potential and Annual Availability of Timber and Forest Biomass Resources for Energy Considering Inter-Prefectural Trade in Tohoku Region of Japan †

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Abstract: To promote sustainable timber and forest biomass utilization, this study estimated technically feasible and economically viable availability considering forest regenerations. This study focuses on five prefectures, namely, Aomori, Iwate, Miyagi, Akita, and Yamagata, and considers the trade between these prefectures. The data used in this study include forest registration (tree species and site index) and GIS data (information on roads and subcompartment layers) from the prefectures for private and communal forests. Additionally, this study included GIS data (subcompartment layers, including tree species) from the Forestry Agency of Japan for national forests as well as 10-m-grid digital elevation models (DEMs) from the Geographical Survey Institute. As a result, supply potentials of timber and forest biomass resources were estimated at 11,388,960 m^3/year and 2,277,792 m^3/year. Then, those availabilities were estimated at 1,631,624 m^3/year and 326,325 m^3/year. Therefore, the rate of availabilities to supply potentials was 14.3%. Since timber production, and wood chip usage from thinned woods and logging residues in 2018 were 4,667,000 m^3/year and 889,600 m^3/year, rates of timber and forest biomass resource availabilities to those values were 35.0% and 36.7%, respectively. Furthermore, the demand was estimated at 951,740 m^3/year from 100,000 m^3/year with the generation capacity of 5 MW. The rate of forest biomass resource availability to the demand was 34.2%. The rates were increased to 64.1% with additional regeneration subsidy, 173.3% with thinning subsidy, and 181.5% with both subsidies. Thus, the estimated availability with both subsidies met the demand sufficiently in this region.

Keywords: Feed-in tariff; harvesting system; subsidy; timber trade; woody biomass power plant

1. Introduction

To promote sustainable timber and forest biomass utilization, technically feasible and economically viable availability should be estimated considering forest regenerations. Yamamoto et al. [1] extracted production forests and estimated the annual availability of forest biomass resources under profitable forest management of private and communal forests as well as national forests in Tochigi Prefecture, Japan. Production forests were extracted as subcompartments where expected revenues surpassed all costs, from planting to final harvest, based on a 55-year rotation. Battuvshin et al. [2] expanded the estimates by including three prefectures (Fukushima, Ibaraki, and Gunma) that surround Tochigi, and considering the inter-prefectural trade. Fukushima belongs to Tohoku

region whereas Ibaraki, Tochigi, and Gunma belong to Kanto region in Japan. The present study estimated the supply potential and availability of forest biomass resources of cedar, cypress, pine, and larch for woody biomass power generation in Aomori, Iwate, Miyagi, Akita, and Yamagata prefectures north neighboring to Fukushima in Tohoku region.

2. Materials and Methods

The data used in this study include forest registration (tree species and site index) and GIS data (information on roads and subcompartment layers) from the prefectures for private and communal forests. Additionally, this study included GIS data (subcompartment layers, including tree species) from the Forestry Agency of Japan for national forests as well as 10-m-grid digital elevation models (DEMs) from the Geographical Survey Institute.

Specifically, production forests were extracted and annual availability of timber and forest biomass resources was estimated in the following order: 1) estimation of supply potential and revenue of timber and forest biomass resources from thinning and final felling operations; 2) estimation of total expenses from planting to final felling operations; 3) estimation of economic balances during rotation ages; 4) extraction of profitable subcompartments as production forests; 5) estimation of availability of timber and forest biomass resources on the basis of supply potential from profitable subcompartments. Then, annual availability was estimated by dividing the availability by each rotation period. Full technical details on the data analysis methods can be found in earlier papers [1,2].

3. Results and Discussions

The annual supply potentials of timber and forest biomass resources were estimated at 11,388,960 m^3/year and 2,277,792 m^3/year. After forest operation systems were determined according to topography and harvesting costs were estimated, the annual availability of timber and forest biomass resources was estimated at 1,631,624 m^3/year and 326,325 m^3, respectively. Therefore, the ratio of availability to supply potential was 14.3%. The ratio of Miyagi is the highest because of low harvesting costs with ground-based system. On the other hand, the rates of Akita and Yamagata was low because of low timber prices and high regeneration costs with heavy snow. By applying the subsidy, the rates of availability to supply potential increased to 26.8% with the additional subsidy, 72.5% with the thinning subsidy, and 76.0% with both subsidies. The ratio of Akita was still low because of low timber prices. The demand was estimated at 953,340 m^3/year from 100,000 m^3/year with the generation capacity of 5 MW. The rate of forest biomass availability to the demand was 34.2%. The rates were also increased to 64.1% with additional regeneration subsidy, 173.3% with thinning subsidy, and 181.5% with both subsidies. Thus, the estimated availability with both subsidies met the demand sufficiently in this region.

Since the actual timber production of the five prefectures was 4,667,000 m^3/year in 2018, the estimated annual availability of timber with thinning subsidy, 8,258,304 m^3/year, was almost double of the actual timber production. The estimated annual availability of forest biomass resources with thinning subsidy, 1,651,845 m^3/year, was also almost double of the actual usage in 2018, 889,601 m^3/year. This was because subsidy was applied to all stands in the estimations although the subsidy budget was limited. Therefore, estimations should be conducted while considering limited budgets. For example, Moriguchi et al. [3] determined subsidized forest stands to satisfy the required annual wood yield with minimum governmental expenses.

4. Conclusions

This study estimated the technically feasible and economically viable availability considering forest regenerations for five prefectures, namely Aomori, Iwate, Miyagi, Akita, and Yamagata. In order to estimate harvesting costs, harvesting systems were determined according to topography. The estimated availability with thinning and additional regeneration subsidies met the demand sufficiently in this region. Thus, subsidies play an important role in the profitability of forestry operations as well as the supply of timber and forest biomass resources in Japan. This study modeled trades between prefectures of Tohoku region. The future study expands the model to the whole of Japan.

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