Future Prediction of Biomass Supply Potential under Climate Change Scenarios using Forest Landscape Simulation Model for Regional Circular and Ecological Sphere

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The forming Regional Circular and Ecological Sphere (RCES), a concept to circulate the tangible and intangible natural resources and ecosystem services within the independent and distributed regions, is a key to establish sustainable spheres under the depopulation society in Japan. Under this social context, biomass resources, which are abundantly distributed in the forest covering 70% of the Land, are expected to replace the fossil intensive energy and material systems. Simultaneously climate change impacts on forests are concerned, so the forecasting of forest dynamics in the future and evaluating the potential availability are required. This study explored the requirement of RCES in the Okuaidu region in Fukushima prefecture, where a regional circulating smart community is planned, by simulating the potentials of woody biomass provisioning services.

A forest landscape model, LANDIS-II, was employed to simulate the future forest aboveground biomass (AGB) under RCP (Representative Concentration Pathways) scenarios until 2050. In the LANDIS-II model, the initial conditions of the forest ecosystem in the Okuaidu region were set by private forest inventory, and the annual growth rates by species were calibrated by referring the standard harvest table of Fukushima prefecture. The statistically downscaled climate data was used as the input climate data for LANDIS-II; 1km resolution of RCP 2.6 and 8.5 scenarios of CMIP5 (MIROC-5,MRI-CGCM3) developed by NARO. The spatial resolution was 500 m grid cell. The annual AGB growth by tree species and by age in each cohort was calculated under the five combinations of RCPs, climate models, and current climate using a Monte Carlo simulation with 10 repetitions. The cumulative AGB growth by 2050 in each grid cell was aggregated by five town’ s administrative boundaries (Yanaidsu town, Mishima town, Kaneyama town, Showa village, Tadami town). The biomass head supply potential was estimated by assuming that all AGB can be converted to wood pellets and available as biomass energy. Finally, the total energy supply and demand balances of each town were evaluated and the energy surplus, which can be tradable to external regions was estimated.

The cumulative change of AGB in 2050 by RCP scenarios and by climate model was shown in Figure 1. The AGB increased during the simulation period in all cases including the non-climate change case. The mean AGB increased by 17% in both RCP2.6 and 8.5 scenarios.

Under the RCP8.5 scenarios of MIROC5 and MRI-CGCM3 models and the RCP2.6 scenario of MRI-CGCM3 model, the AGB increased to 1.9, 1.8, 2.1 Tg-C in 2050, respectively. These AGBs are significantly higher than the current climate situation.

In all towns, the estimated biomass heat energy supply potentials were higher than the energy demand (Figure 2). Tadami town had the highest supply potential, and 1.7 and 2.3 times higher in RCP2.6 and 8.5 scenarios, respectively, than the energy demand. This energy supply potential was supported by broad-leaved trees, such as the Japanese beech, which is the target of conservation activities. Trade-offs between energy supply and multiple ecosystem services should be taken into consideration if the town utilizes biomass resources.

The future tasks are to propose (1) optimized boundaries and hopeful counterparties of RCES in terms of woody biomass energy exports from the Okuaidu region, (2) designs of anti-disaster-oriented alternative woody biomass energy utilization system in increasing emergency situations of the Okuaidu region under

climate change.

Keywords: Regional CES, climate change impacts, RCP scenarios, aboveground biomass, LANDIS-II

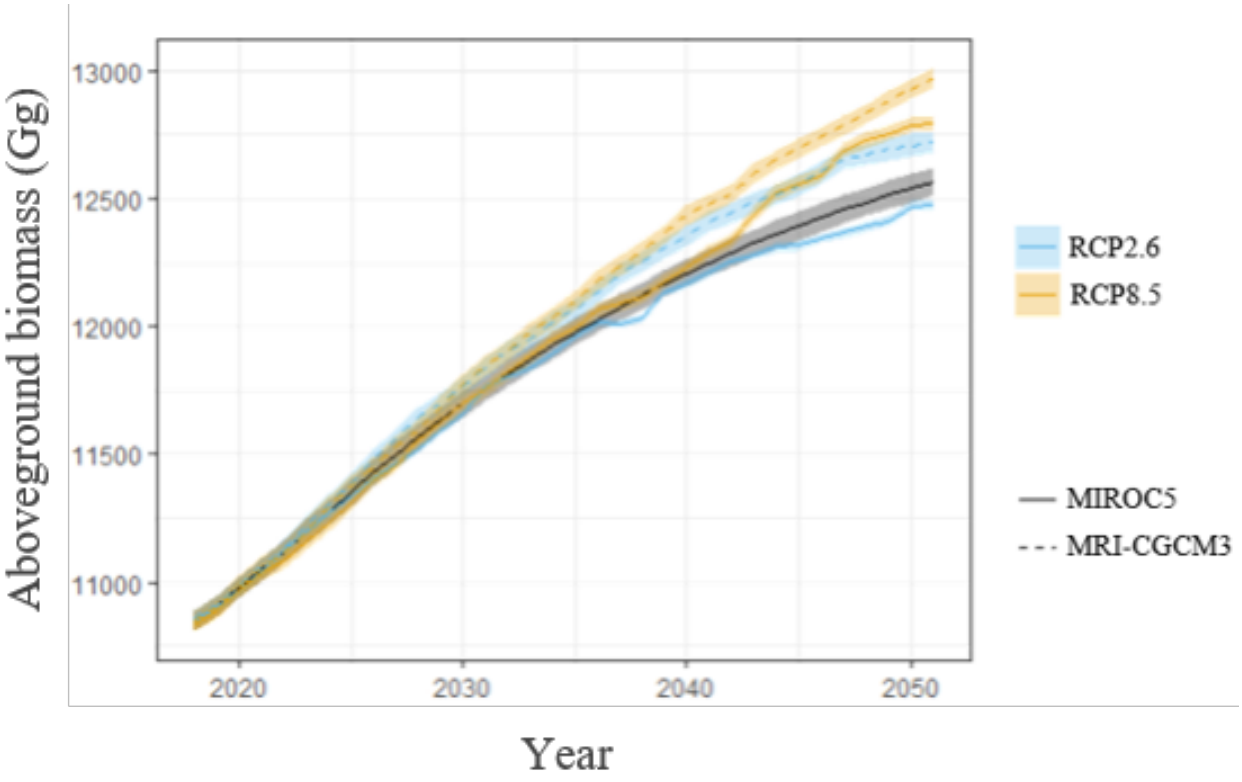

Figure 1. Cumulative change of AGB in 2050 by RCP scenarios and by GCMs

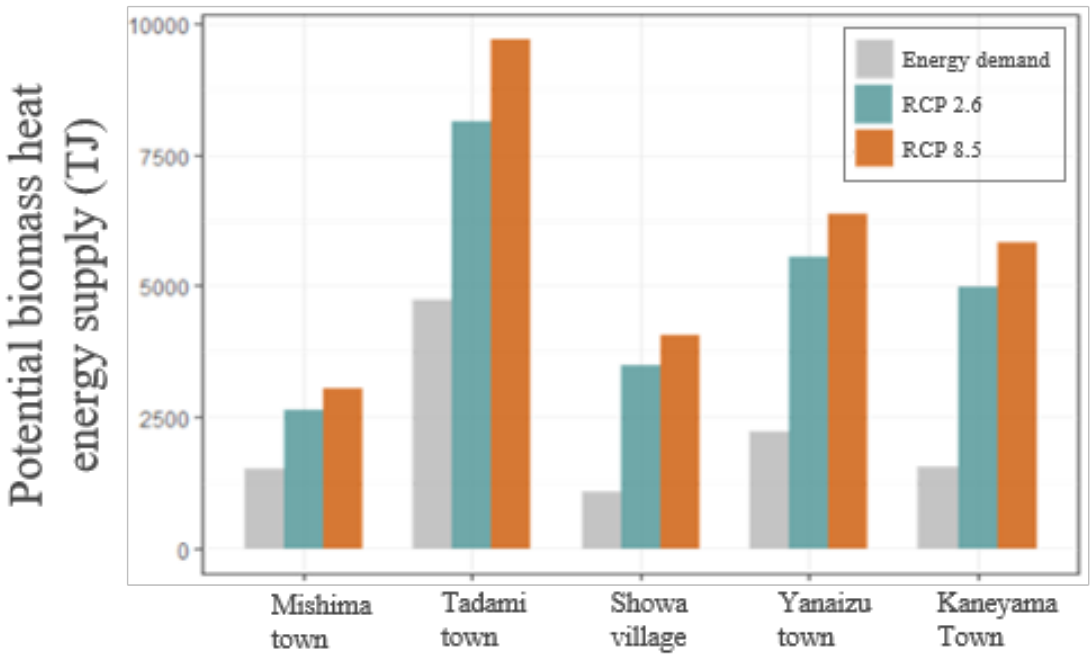

Figure 2. Potential biomass heat energy supply by RCP scenarios and energy demand for each town

