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Potential accounting of regional biomass resource circulations in Japan: A prospective on regional rural–urban partnerships

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ABSTRACT

In this paper we demonstrated an assessment framework to address biomass resources circulation in the context of rural–urban partnerships in pursuit of sustainability. Specifically, we performed mid- to long-term discrete-event simulations of the possibility of combining the supply of biomass resources from crop, livestock, and forestry operations in rural areas with the organizational design of financial mechanisms based on urban resident participation by looking into nine regions in Japan, and evaluated policy options from the viewpoint of farm income, reduction in emission of greenhouse gasses (GHG), and self-sufficiency rates. We found that food self-sufficiency rate (calorie-based) can be improved relative to the BAU option in every region by adopting the "Rehabilitation of Food Production" option. We argue that the proposed assessment framework allows us to discuss the potentials of rural–urban relationships from the viewpoints of sustainability in a concrete manner, despite various socio-economic factors and uncertainties.

1. Introduction

Today, as recognition of the finite nature of the Earth's resources grows, various efforts to create sustainable societies are being undertaken in countries and regions throughout the world

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(Meadows et al., 2004; The World Commission on Environment and Development (WCSD), 1987; United Nations Conference on Environment and Development (UNCED), 1992). In particular, from the standpoint of energy resources, what is being sought is a shift away from reliance on exhaustible resources, as exemplified by fossil fuels, and toward a society founded on renewable resources (Daly, 1997). In addition to solar, wind, water, and geothermal power, there are expectations due to the potential of biomass resources derived from living creatures as renewable resources. The main biomass resources are regional resources derived from agriculture and forestry, including so-called unused biomass such as livestock excreta and other waste biomass, non-food agricultural crops (rice and wheat straw, etc.), forest harvest residue, and resource crops (New Energy and Industrial Technology Development Organization of Japan (NEDO), 2005). These biomass resources are unique in that their abundance follows changes in socio-economic activity. As such, the role to be played by agriculture and forestry operations in rural areas is extremely large.

However, agriculture and forestry operations in Japan's rural areas are currently facing many challenges. They include a shift in population and outflow of labor from the rural to urban regions due to the advancement of urbanization, and an aging demography of individuals engaged in agriculture, leading to serious problems such as an increase in abandoned arable land and a shortage of individuals to take over agricultural operations (Hayami and Yamada, 1991; Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF), 2011)

While the ratio of renewable energy to the total supply of primary energy in Japan is almost equivalent to that of the United States and EU, the composition of biomass energy still remains small (New Energy and Industrial Technology Development Organization of Japan (NEDO), 2010). In fact, utilization of biomass energy in Japan as of 2010 was 10.9 million kilo litter (oil equivalent), which is estimated to be 1.91% of the total primary energy supply (Ministry of Economy, Trade and Industry (METI), 2012). Furthermore, although plans for creation of Biomass Towns have been under development since the adoption of the “Biomass Nippon Strategy” by the Cabinet of Japan in 2002 (Kuzuhara, 2005), a policy evaluation report issued by the Ministry of Internal Affairs and Communications (MIC) (2011) identified numerous challenges regarding the use of biomass resources in Japan. These include the fact that more than 98% of forest harvest residue and more than 70% of food waste and non-food agricultural crops remain unused, the fact that approximately 70% of biomass-related facilities are operating at a loss, and the fact that there is insufficient data, such as results from biomass-related projects, to evaluate the efficacy and efficiency of policy (Ministry of Internal Affairs and Communications (MIC), 2011). Meanwhile, the concept of regional circulation zones has been proposed in Japan, and discussions are ongoing with the goal of the development of material-circulation systems, including biomass utilization, at scales appropriate for the characteristics and resources of a given region (Ministry of Environment of Japan, 2012). The biomass resources considered in this paper are circulative resources that can be used efficiently, from an economic standpoint, in “regions” encompassing multiple cities and villages without excessively burdening the environment. Efforts seeking the best way to collaborate within regions, which include urban areas capable of serving as economic bases and providing human resources in order to promote cyclic use of biomass resources, have already begun. However, the partnership between rural and urban that leads to biomass utilization has been limited.

On the basis of the above background, we argue that it is indispensable to develop regional rural–urban partnerships and facilitate the utilization of unused biomasses in the context of creating sustainable societies (National Agriculture and Food Research Organization (NARO), 2006; Sato et al., 2010; Ren et al., 2010; Tsuda et al., 2009,2011; Tsuda and Umeda, 2010). “Regional rural–urban partnerships” here refers to the creation of complementary and equal relationships between urban and rural areas based on a re-evaluation of the diverse functions of rural areas (Organisation for Economic Co-operation and Development (OECD), 1998) with the ultimate goal of maintaining and developing ecological services provided in rural areas through cooperation between urban and rural areas. To this end, it is necessary to, on the one hand, clearly assess the stock of resources possessed by rural areas and provide multiple flows from the rural to the urban areas while making “smart” the demand in urban areas, and on the other hand, to gain an understanding of the promotional factors involved in regional partnerships, and thereby expand the flow of human resources and labor, financing, etc., from urban areas to rural areas, and