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## **Multi-scale Food- Energy-Water Nexus to link national, regional and local sustainability based on resource-sheds and system dynamics modeling: A Case study of Japan**

**Sanghyun Lee**, Makoto Taniguchi, and Naoki Masuhara

Research Institute for Humanity and Nature, Kyoto, Japan (sanghyunsnu@gmail.com)

The aim of this study is to develop a Food-Energy-Water (FEW) Nexus platform based on boundaries of resources and system dynamics modeling. For example, water-shed indicates river basin, aquifer or water supply area regarded as non-tradable boundary. However food-shed indicates both food production and consumption area in addition to food trade. Energy-shed is mainly defined by electricity distribution. Therefore, the boundary of each resource is different and we link water, energy, and food boundaries such as resource-sheds in the FEW Nexus. As a case study, we analyze the interlinkage among national, regional, and local sustainability in terms of resource management and socio-economic-environmental impacts in Japan. First, we analyze the local characteristics of FEW Nexus as a prefecture level using the FEW indices, and assess the potential issues under future industrialization or economic growth situations. Second, we combine the local FEW Nexus into regional platform, for example, the Kansai regional Nexus including Osaka, Kyoto, Shiga, Hyogo, Nara, and Wakayama prefectures. Finally, we adapt the boundary of resource-sheds into the regional Nexus and assess the changes in local resource management on regional resource sustainability using system dynamics modeling. Thus, we assess the impacts of changes about water, energy, and food management in each prefecture on regional water and energy security in Kansai region. This study could contribute to develop a common framework for scientists and policy-makers to evaluate sustainable resource management with multi-scale perspective, thus it has the potential to achieve integrated water, energy and food security.