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Renewable Energy Production from Waste to Mitigate Climate Change and Counteract Soil Degradation – A Spatial Explicit Assessment for Japan

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Waste production from urban areas is growing faster than urbanization itself, while at the same time urban areas are increasingly contributing substantial emissions causing climate change. Estimates indicate for urban residents a per capita solid waste (MSW) production of 1.2 kg per day, subject to further increase to 1.5 kg beyond 2025. Waste water and sewage production is estimated at about 260 liters per capita and day, also at increasing rates. Based on these figures, waste – including e.g. MSW, sewage and animal manure – can generally be assumed as a renewable resource with varying organic components and quantity.

This paper demonstrates how new and innovative technologies in the field of Waste-to-Green Products can help in various ways not only to reduce costs for waste treatment, reduce the pressure on largely overloaded dump sites, and reduce also the effect of toxic materials at the landfill site and by that i.e. protect the groundwater. Moreover, Waste-to-Green Products can contribute actively to mitigating climate change through fossil fuel substitution and carbon sequestration while at the same time counteracting negative land use effects from other types of renewable energy and feedstock production through substitution. At the same time, the co-production and recycling of fertilizing elements and biochar can substantially counteract soil degradation and improve the soil organic carbon content of different land use types.

The overall objective of this paper is to assess the total climate change mitigation potential of MSW, sewage and animal manure for Japan. A techno-economic approach is used to inform the policy discussion on the suitability of this substantial and sustainable mitigation option. We examine the spatial explicit technical mitigation potential from e.g. energy substitution and carbon sequestration through biochar in rural and urban Japan. For this exercise, processed information on respective Japanese waste production, energy demand (population density) and transport infrastructure is used as input data to an engineering model (BeWhere) for optimizing scale and location of waste treatment plants with potential energy and fertilizer co-generation.

Finally, this paper quantifies the economic dimension of mitigation through innovative waste treatment while considering the additional business-feasibility and potential benefits from waste treatment co-products such as energy generation, fertilizer and biochar production for counteracting soil degradation.