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学位論文題目　Unlocking the Electricity Recovery Potential from Sustainable Management of Pig Manure Based on Geographic Information System Analysis: Case Study in Hanoi, Vietnam
（地理情報システム分析に基づく持続可能な豚糞管理からの電力回収可能性の解明：ベトナム ハノイ市の事例）

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論　文　の　要　旨

Pig production has greatly contributed to economic development in Vietnam. However, the lack of appropriate management of large amounts of pig manure has caused serious adverse environmental impacts including greenhouse gas (GHG) emissions. To address this challenge, Ms. Dao Minh Khue explored the potential of biogas production from manure in Hanoi. The author aimed to simultaneously optimize potential biogas production and reduce GHG emissions from pig manure. The specific objectives of this study are to (i) identify suitable areas for biogas plants based on geographic feasibility and socio-economic criteria; (ii) analyze the spatial distribution and amount of the potential biogas production from pig manure; (iii) evaluate potential benefits of introducing biogas production to satisfy the electricity demand and reduce GHG emissions. The author first applied site suitability analysis to identify available locations for the sitting of biogas plants by (i) analyzing geographic criteria to restrict sensitive areas, (ii) considering socio-economic factors with Analytic Hierarchy Process to identify suitable areas to be in line with those factors, (iii) intersecting the restriction map and the suitability map to obtain the final suitability map with available areas for sitting biogas plants. The author then estimated biogas production capacity for pig farms and carried out a cluster analysis to identify spatially statistically significant clusters with high density of potential biogas production and minimization of distance among them by Spatial Analysis. After that, the author designed a baseline scenario and proposed three other scenarios based on the farms scale within selected clusters of farms in order to optimize available input manure and theirs potential output capacity. From here, the location, number, scale and capacity of biogas plants for each of the proposed scenarios were determined. Finally, the study calculated the net greenhouse gas emissions including methane, nitrous oxide (from manure decomposition) and avoided carbon dioxide (from electricity generation from biogas) for each scenario and compare with the baseline scenario.

The result shows that for scenario 1 with large scale farms, there are two possible biogas plants with capacity of 1,218 and 1,350 kW in Son Tay and Thach That district respectively. For scenario 2 with medium scale farms, there are two potential biogas plants with capacity of 476 and 363 kW in Son Tay and Thach That district respectively. For scenario 3 with small scale farms, there is one possible biogas plant with capacity of 308 kW in Son Tay. The results could help meet the electricity demand of Son Tay, Thach That district with 1.75% and 0.76% respectively for 2025 with utilization from approximate 8% of total pig number in Hanoi.

The GHG emission reduction from developing biogas plants are also meaningful. In details, net GHG emission of scenario 1,2,3 are -12,307; -4,021; -1,478 ton of CO2 eq/year respectively while the baseline scenario brings to 66,971 ton CO2 eq /year of net GHG emission. The GHG emission gap between those scenarios is 84,777 ton CO2 eq/year.

The results of the study highlight the importance of identifying not only the potential amount of biogas at nearby spatial clusters but also identifying optimum locations, number and scale of those biogas plants which are able to meet electricity demand in Hanoi rural areas as well contribute to GHG emission reduction. This could be a viable alternative to meet future electricity demand in rural areas with renewable resources. The results open a great opportunity to address local's energy security with renewable energy and reduce GHG emissions effectively.

審　査　の　要　旨

This study addressed the lack of appropriate management of large amounts of pig manure that has caused serious adverse environmental impacts including GHG emission. Through the use of GIS suitability analysis, cluster analysis, and the analytic hierarchy process (AHP) techniques, the study first analyzed the spatial distribution of pig farms, identified optimal locations for biogas plants, and evaluated potential benefits of introducing biogas production to satisfy the electricity demand and reduce GHG emissions. The results of the study highlight the importance of identifying not only the potential amount of biogas at nearby spatial clusters but also identifying optimum locations, number and scale of those biogas plants which are able to meet electricity demand in Hanoi rural areas as well contribute to GHG emission reduction.

The final examination committee conducted a meeting as a final examination on January 21, 2021. The applicant provided an overview of dissertation, addressed questions and comments raised during Q&A session. All of the committee members reached a final decision that the applicant has passed the final examination.

Therefore, the final examination committee approved that the applicant is qualified to be awarded the degree of Doctor of Philosophy in Environmental Studies .