

学位論文の要旨 (論文の内容の要旨)
Summary of the Dissertation (Summary of Dissertation Contents)

論 文 題 目
Dissertation title

Municipal Solid Waste Management in Nepal: A Case Study of Gorkha Municipality

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Municipal solid waste is a mounting problem for the urban areas of developing countries. The amount of global municipal solid waste generation is increasing faster than the rate of urbanization and it is expected to rise significantly over the years, especially in lower and lower middle-income countries. Although the local governments in developing countries spend up to 50% of municipal budget for waste collection and disposal, its management is far from satisfactory. Nepal is one of the least developed countries in South Asia and municipal solid waste management is the biggest challenge for the local and national government. The average municipal budget allocated for solid waste management is only about 10%, which is spent on solid waste collection, transportation and street-sweeping. Municipalities and community groups in Nepal are mainly characterized by having limited access to information, especially on improving waste management system and using waste in an economically productive way. There is no proper and effective waste collection system and only limited recycling and composting activities are practiced all over Nepal. Haphazard depositing and burning piles of waste along the roads and riversides is a common sight, causing health hazards and environmental problems. The most recent law related with solid waste management in Nepal is the "Solid Waste Management Act, 2011", which gives the local body full authority and responsibility for a proper waste management. It also gives authority to the local body to implement waste segregation at source, impose waste management fees, manage waste by composting and recycling activities, and for proper disposal of waste in sanitary landfill site. However, the law has hardly been implemented by the local governments in Nepal. Although policy implementation is a huge challenge for any government, it is very important to understand the ground issues before any policy is enforced to the public.

Before deciding upon the most effective waste management option, the current status of waste related issues should be identified. It includes how much and what kind of waste is generated, how it is managed, who are the actors involved in its generation and management, what resources do these actors already have to manage the waste, etc. Although the characteristics among urban areas of developing countries are quite common; waste management strategies should be context specific, locally sensitive, critical, creative and owned by the community of concern; as their specific circumstances may be significantly different. This is why there needs to be a comprehensive study on waste, particularly in a country like Nepal where there is hardly any study conducted that has done detailed analysis of waste generation and management practices to suggest for the most effective solution. Therefore, this study was conducted in Gorkha municipality of Nepal for a detailed analysis of solid waste situation and management practices. Gorkha municipality was selected because it is one of the least resource intensive municipalities in Nepal that does not fall under the priority of researchers or implementers, but growing amount of waste nonetheless demands proactive action. It focuses on awareness, behavior and attitude of households; who are the major contributors (75%)

of waste generation; toward waste and its management.

The specific objectives of this study are: to analyze factors affecting households' solid waste generation and identify waste composition, factors influencing households' willingness-to-segregate into organic and inorganic waste, factors impacting households' willingness-to-pay for the improved waste collection service, and finally to evaluate compost making practices including its quality at the household level. In order to achieve these objectives, household survey was conducted in two phases. The first phase was conducted from November to December 2015 to gather households' socioeconomic and other waste related data through face-to-face questionnaire survey. Household sample was selected using stratified sampling technique from all the 15 municipal wards to get the best representative sample of the overall population. The total sample considered in this study is 401 households. Second phase was conducted from February to March 2016 to study the compost making practices using the subsidized compost bin distributed by the local government. Out of 300 households, who received the compost bins, 149 households were selected and interviewed. Six compost samples were also randomly selected to conduct chemical analysis to analyze the compost quality made by using household waste.

Waste characterization and composition study was conducted using one-week data of household waste. Each household were given two plastic bags that was numbered and requested to segregate organic and inorganic waste and to store it for a week. After a week, the waste was collected and taken to the municipality's disposal site. Waste was separated into eight categories and its weight was measured. While analyzing waste composition, organic waste (47.25%) formed the highest share of total waste followed by 37.52% recyclable waste that comprised of 10.38% paper and paper products, 9.88% glass, 6.92% metal, 5.39% plastic, 3.57% textile and 1.38% rubber and leather. The rest 15.23% comprised of other waste. From this study, it is estimated that in Gorkha municipality, households generate about 1,621.4 tonnes of organic waste every year, most of which are uncollected, and the rest discarded in an open dumpsite. The recyclable potential of waste is also very high, which is about 1,287.5 tonnes/year. The remaining waste generation that also includes hazardous waste is about 522.6 tonnes/year, which as of now is discarded in an open dumpsite with other wastes but should be managed in the highest possible environmentally and socially acceptable standard. The rate of household waste generation in Gorkha municipality is found to be 0.24 kg/capita/day and estimated total household waste generation of 9.4 tonnes/day. Ordinary Least Square regression model was employed to assess the socioeconomic factors impacting household waste generation. This study found that household size and household income have positive impact on waste generation, both statistically significant at 1% and thus can be important indicators to forecast solid waste generation trend.

Segregation of waste at source and separate collection of waste is the fundamental step to manage waste as the quality of organic waste and recyclable materials can be preserved, which can reduce the total amount of waste that needs to be collected and managed by the concerned stakeholders. Logit regression model was employed to identify the factors that influence households' waste segregation behavior. This study found that environmental awareness, waste collection service, willingness-to-pay, make compost, and segregated waste for a week variable are statistically significant at 1% level of significance. Income variable is significant at 5% level of significance and gender variable is significant at 10% level of significance. It was revealed that 91% of respondents are willing to segregate waste in the future, which can be trustworthy as they just had first-hand experience of waste segregation in the process of taking part in this study.

The waste collection service is provided for free and is restricted only to limited areas in Gorkha municipality. With the assumption that the collected amount from the households would help improve the collection service, this study employed Contingent Valuation method which directly asks the beneficiaries their willingness-to-pay the maximum amount. Logit regression model was used to determine the factors that influence willingness-to-pay for improved waste collection service and tobit regression model was used to determine the factors that influence the maximum amount of money that the households are willing to pay for the improved waste collection service. This study found that the majority of surveyed households (61%) are willing to pay for the improved waste collection service. The mean willingness-to-pay amount is NRs. 73.38 (0.72 US\$) per month. The factors that significantly influence households' willingness-to-pay are monthly household income, education of household head, environmental awareness and waste collection service. The significant factors that influence the maximum amount of money households are willing to pay for improved waste collection service are monthly household income, environmental awareness and waste collection service.

Household composting is known to be an effective approach to manage organic waste, which reduces significant burden for the municipality to collect and manage household waste, thus minimizing the amount of waste going to the dumping or landfill site for final disposal. This study found that 56% of the surveyed households are continuing to use compost bin. The reasons for those households who are not using the bin are because of insect invasion, foul smell, leachate production, damaged bins and natural calamity. Kitchen and garden waste are the most common types of waste that were used as an input for household composting. The compost is used for crop production and flowering. Majority of respondents (82%) also perceived to have better production of vegetables in the form of size and quality after applying home-made compost. Chemical analysis of the sampled compost suggests that compost made from household waste does have nutrient content that can definitely add value to the soil when applied. However, higher level of heavy metals such as cadmium shows the importance of compost testing and to take necessary steps to improve its quality.

備考 論文の要旨はA 4判用紙を使用し、4,000字以内とする。ただし、英文の場合は1,500語以内とする。

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