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Influencing factors of domestic waste characteristics in rural areas of developing countries

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ABSTRACT

Waste management in rural areas has become a major challenge for governments of developing countries. The success of waste management decisions directly lies in the accuracy and reliability of the data on which choices are based; many factors influence these data. Here, we examined the factors influencing domestic waste in rural areas of developing countries (RADIC), using both field surveys and by reviewing previous literature. The social factors included population, education and culture. There was a positive linear relationship between waste generation amount and population size (R^2 = 0.9405). Environmental education, training and demonstration projects played a positive role in improving people's awareness of the benefits of recycling and reducing waste. Traditional and national cultures, consumption and living habits contributed to variations in the generation and composition of domestic waste. Generally, practices related to conservation of and reverence for nature and green consumption encourage people to reduce, reuse and recycle waste in their daily life. Economic factors included household income and expenditure, energy and fuel structure, and types of industry that occurred in villages. A Kuznets inverted "U" curve relationship existed between domestic waste generation and people's income in rural areas of China. However, the waste generation rate had a linear relationship with the gross national income per capita in RADIC. The composition, bulk density and calorific value of domestic waste were variously affected by the energy and fuel structure and the types of industry that occurred. The natural factors included geography and climate (including rainfall, humidity, temperature and harvest seasons). The moisture content of waste was directly influenced by rainfall and humidity. Temperature affected waste characteristics by influencing residential heating modes. The waste characteristics were also influenced by the mixing of agricultural and aquacultural waste into domestic waste in the harvesting season. In different geographies, significant differences of domestic waste characteristics were observed as a result of comprehensive effects caused by multiple factors. Other factors included the administrative levels of communities and survey methods. The characteristics of domestic waste in towns or central villages were similar with those in cities, but were different from those in common villages (the smallest type of community). The domestic waste sampled in households indicated a lower rate of generation and lower ash content than when the waste was sampled at transfer stations or dumping sites. Based on the above analysis, the factors influencing domestic waste must be considered in order to optimize the design of waste management strategies in the RADIC. Furthermore, it is valuable and important to obtain more accurate data about waste characteristics.

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1. Introduction

Solid waste management is a global challenge, especially in economically developing countries due to their growing populations, life style changes, rising community living standards, and increasing waste generation (Hassan et al., 2016). Poorly managed domestic waste including the lack of sanitation services and inadequate waste management facilities in developing countries has resulted in serious environmental pollution, landscape damage and has even had a negative influence on local people's health (Apostol and Mihai, 2012; Balasubramanian and Birundha, 2011).

Generally, the sustainable development of countryside requires an integral waste management strategy that includes all the stages from waste collection and transport to waste treatment and disposal. These stages are directly linked to the quantity of waste and its characteristics. It is difficult to optimize the design of the required infrastructure and facilities, or indeed management strategies, based on inaccurate estimates of waste generation and characteristics, which are dependent on many factors. Therefore, in the context of rural areas, with their different socioeconomic situations (Iraia et al., 2015), climate (Maklawe et al., 2012), geography (Han et al., 2015), cultures (Wei et al., 2009), population density and other variables (Li et al., 2012a; He et al., 2014), the influencing factors of domestic waste characteristics (IFDWC) have become very important for managing solid waste and implementing reduction and recycling strategies in rural areas of developing countries (RADIC).

Research on municipal solid waste (MSW) in cities has shown that economy and urban development are important factors that influence MSW generation (Iraia et al., 2015; Liu and Wu, 2010). MSW generation and composition are significantly affected by urban population and its proportion, energy consumption, collection areas, transport vehicles, waste disposers, average family size, employment status, income, number of room(s) occupied by households, people's concern about the environment and willingness to separate the waste, tourism activity, education and other factors (Chu et al., 2016; Iraia et al., 2015; Liu and Wu, 2010; Rafia et al., 2011; Sankoh et al., 2012; Yang et al., 2010). However, little attention has been paid to rural domestic waste in most developing countries (Zarate et al., 2008), especially to the IFDWC in rural areas.

On one hand, the success of waste management planning not only relies on understanding domestic waste characteristics but also on the accuracy and reliability of the data used (Iraia et al., 2015). On the other hand, few studies have focused on the IFDWC in the RADIC. In this research, we conducted a field survey and a literature review and used China as a typical example of developing countries to study the IFDWC in the RADIC, including the social, economic, natural and other factors. The aims of this work were to comprehensively analyse and discuss the IFDWC in the RADIC and to clarify the factors that affect the characteristics of domestic waste. It is useful to obtain accurate and reliable data for domestic waste source classification, recycling, treatment and disposal in the different RADIC.

2. Materials and methods

2.1. Data from field surveys

An investigation using questionnaires was carried out using a door-to-door approach at 580 randomly selected households in 59 villages of six provinces in West China. The investigated provinces were Sichuan, Yunnan, Guizhou, Tibet, Xinjiang and Gansu (Fig. 1), where the rural population was 122.09 million in 2014 (about 20% of rural population in China). The per capita disposable income of rural residents ranged from 912 to 1359 US dollars per year which was less than the national average of 1525 US dollars per year in 2014.

First, the socioeconomic characteristics of each household were obtained through a face-to-face interview; these data included age, education, fuel types, livestock breeding, family size and household income. Then, a bag was provided to each household for collecting all domestic waste produced during a 1–2 day period. All bags from a single village were collected and mixed together, from which a 1-kg sample was retrieved to represent the wet waste composition of the village. Subsequently, the sample was returned to the laboratory for analysis according to the "Sampling and Analysis Methods for Domestic Waste" (CJ/T 313-2009) promulgated by the Ministry of Housing and Urban-rural Development of the People's Republic of China.

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