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Improving knowledge and practices of mitigating green house gas emission through waste recycling in a community, Ibadan, Nigeria

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ABSTRACT

Throughout the world, waste sector has been implicated in significant contribution to anthropogenic greenhouse gas (GHG) emissions. Involving communities in recycling their solid waste would ensure climate change effect mitigation and resilience. This study was carried out to improve waste management practices through a community-led intervention at Kube-Atenda community in Ibadan, Nigeria. The study adopted a quasi-experimental design, comprising mixed method of data collection such as semi-structured questionnaire and a life-cycle-based model for calculating greenhouse gas generation potentials of various waste management practices in the area. A systematic random sampling was used to select sixty (60) households for a survey on knowledge, attitude and practices of waste management through Recovery, Reduction, Reuse and Recycling (4Rs) before and after the training intervention. Data collected were summarised using descriptive statistics, chi-square test, *t*-test and ANOVA at $p = 0.05$. The mean age of the respondent was 49.7 ± 16.7 and 68.3% were females. Respondents' knowledge scores before and after the intervention were significantly different: 7.07 ± 1.48 and 11.6 ± 1.6 while attitude scores were: 8.2 ± 2.3 and 13.5 ± 0.8. There were significant differences in the major waste disposal practices in the community before and after the intervention. All (100%) the participants were willing to participate in waste recycling business and the model predicted that adoption of 4Rs strategy had a great potential in saving greenhouse gas emissions in the community. The behaviour of the community people has changed towards waste management that promote climate change mitigation and adaptation through waste reduction, reuse, and resource recovery.

1. Introduction

In Nigeria, as well as other countries of the world, the health and environmental effects of municipal solid waste have been extensively explored (Forastiere et al., 2011; Nabegu, 2011; Zagozewski et al., 2011; Aljaradin and Persson, 2012; Oguntoyinbo, 2012; Abila and Kantola, 2013; Burmamu et al., 2014; Brunner and Rechberger, 2015; Buonanno and Morawska, 2015; Leckner, 2015; Aremu and Ritesh, 2016; Hammed et al., 2016, 2017). According to Intergovernmental Panel on Climate Change (IPCC), waste sector significantly contributed to anthropogenic greenhouse gas (GHG) emissions, accounting for approximately 5% of the global greenhouse budget (IPCC, 2006). This 5% consists of methane (CH_4) emission from anaerobic decomposition and carbon dioxide (CO_2) from aerobic decomposition of solid waste. It has been reported that developing countries and emerging economies could reduce their national GHG emissions by 5% through adoption of municipal waste management systems that have focus on waste recycling (IFEU, 2009). Also, by establishing what is called "closed loop waste management", German waste management activities was able to reduce about 20% of the overall GHG over the period 1990–2005 (Troge, 2007). The IPCC calculations take into account only end-of-pipe solid waste management strategies such as: landfill/waste dumping, composting, waste incineration and sewage disposal while the positive impacts of waste recovery, reduction, reuse and recycling (4R's) on GHG emission are directly accounted for in the GHG inventories reported to the United Nations Framework Convention on Climate Change (UNFCCC) under the Kyoto Protocol (IFEU, 2009).

Accordingly, a number of studies have specifically focused on GHG emissions, their associated global warming potentials and climate change from waste management activities in Nigeria

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(Ahmed, 2012; Anselm and Stephen, 2012; Ogundipe and Jimoh, 2015; Kofoworola, 2016) and European countries (Fruergaard and Astrup, 2011; Manfredi et al., 2011; Blengini et al., 2012). However, a successful waste management approach for Nigeria and the African continent requires not only identifying solid waste related problems but providing practical solutions to the problems. This has to do with community-action-oriented projects on all aspects of waste management, including adoption of the 4Rs concept, changing people behaviour through sensitisation and awareness creation on the ill effects of poor waste management, identifying the most environmentally friendly and economically viable alternative to the current waste management practices, using life-cycle assessment (LCA) approach and building community people's capacity in resource and energy recovery from the waste. Lagos municipal authorities have failed to achieve proper practices of waste storage and segregation at source owing to lack of community participation (Tunmise, 2014). Improving the public general knowledge and awareness creation in the form of education and technical training (Sridhar et al., 2016) is therefore important in making waste recycling a huge success. As demonstrated in a study conducted by Lilliana et al. (2013), citizens that received information about the benefits of recycling were more likely to participate in recycling campaigns.

Life-cycle assessment of waste management practises has proven to be a suitable tool for providing a reliable comparison between waste management technologies and analysing the related benefits and drawbacks (Fruergaard and Astrup, 2011). As such, several studies in the last years assessed the beneficial environmental aspects of waste management using LCA-based approach (Giugliano et al., 2011; Mahdi et al., 2016). Soares and Martins (2017) identified socio-political-economic barriers to the process implementing alternative and complementary technologies for generating electricity from MSW in São Paulo, Brazil, using LCA. Ogundipe and Jimoh (2015) used LCA methodology to determine municipal solid waste (MSW) management strategy for Minna, Niger State, Nigeria. Mohammad and Kenneth (2012) utilised Solid Waste Management Greenhouse Gas (SWM-GHG) calculator to compare four scenarios representing the current and suggested technologies in Jordan and observed reduction of GHG emission of about 63 175 tonne CO_2-eq/year in a scenario where all the organic waste was recovered. However, it should be noted that a comprehensive LCA study should include other environmental impacts apart from climate change such as acidification potential, eutrophication potential and human toxicity (Mahdi et al., 2016).

The failure of the current end-of-pipe approach, based on solid waste collection and disposal, to mitigate climate change effects such as flooding in Nigeria is quite visible. This situation puts an urgent need for introducing an integrated and holistic approach that will not only protect the environment but build people's capacity in wealth creation from waste for poverty reduction, climate change resilience, improved health and self-esteem. The current study was therefore aimed at assessing the effects of a community-led waste recycling sensitisation and training intervention on knowledge, attitude and practices of community people and a life-cycle- based environmental impacts of various waste management practices for reducing greenhouse gas emissions in the community.

2. Material and methods

2.1. Study area

Ibadan is located in the south-western part of Nigeria on Longitude 3°53′ East of Greenwich meridian and Latitude 7°34′ North of the Equator. The city is the second largest in Africa and fourth most populated in Nigeria with an estimated population of about four million people (NPC, 2006). It is in 128 km northeast of Lagos and 345 km southwest of Abuja, the federal capital. The city comprises eleven contiguous local government areas with sub-division into five (5) urban areas- Ibadan North, Ibadan North-West, Ibadan South-West, Ibadan South-East and Ibadan North-East and six (6) peri-urban (Ibadan less city) consisting of Egbeda, Akinyele, Moniya, Ona-Ara, Lagelu, Oluyole and Ido. Like many other urban centers in Nigeria, Ibadan grew naturally without any form of master planning. Kube Atenda community (Fig. 1) that was purposively selected for this study based on its location in high density area with poor waste management problem (Fig. 2) is located in Ibadan Northeast local government area. The community is over populated (10,000 people) with low-income people due to its closeness to major commercial centres in the city which has impacted waste generation and management in the area.

2.2. Study design and sampling techniques

This study adopted community-based quasi-experimental study design and the sample size was calculated using a simplified form of comparison between two proportions (Eq. (1)) thus:

$$n = \frac{(Z_{\propto} + Z_{\beta})^2[P_1(1 - P_1) + P_2(1 - P_2)]}{(P_1 - P_2)^2} \quad (1)$$

where n = minimum sample size, $Z\alpha = 1.96$ (95% level of confidence), $Z\beta = 0.84$ (80% power), $P_1 = 0.25$ (baseline prevalence- on assumption), $P_2 = 0.50$ (anticipated 25% increase). From Eq. (1), $n = 55 \infty 60$. A systematic random sampling was used to select sixty (60) respondents (household heads) for the survey and training. However, 5 people were dropped out between pre- and post-intervention.

2.3. Procedures for data collection

Mixed method (quantitative and qualitative) approach was adopted for data collection. This included: interviewer- administered and semi-structured questionnaire, Focus Group Discussion (FGD) guide, observational checklist for waste characterisation and SWM-GHG calculator developed by Institute for Energy and Environmental Research (IFEU) for assessing GHG emission potentials of waste management practices in the community. The questionnaire was used to collect information on socioeconomic status, social environment/infrastructure status, ethnic relations, perceived health issues and knowledge attitude and practices of waste management before and after the intervention.

A total of 12 questions were used to assess respondents' knowledge and practices of the respondents were assessed with 14 questions. Correct response to each of these questions was given one score while a wrong response was given zero score. Half of the total correct scores, which is 6 (for knowledge) and 7 (for practices) were set as a cut-of mark so that respondents that scored the cut-of marks and above had good knowledge or good practice and those scored below the cut-of marks had poor knowledge or poor practices, as the case may be. Mean knowledge scores was calculated by finding the average of all the respondent's correct marks. That is, summation of individual correct scores divided by the total number of respondents.

Two focus group discussion sessions were organised for male and female respondents separately in the community with eight members in each group. The information obtained was used to design the questionnaire. Physical characterisation of waste generated in the community was carried out for consecutive three weeks, using simplified tools such as picker, rake, weighing scale