Greenhouse gas emissions from non-recyclable residual household waste within domestic wheeled bins

Conference or Workshop Item

GREENHOUSE GAS EMISSIONS FROM NON-RECYCLABLE RESIDUAL HOUSEHOLD WASTE WITHIN DOMESTIC WHEELED BINS

C. BOARDMAN*, S. BURNLEY*, V.GAUCI**, T. GLADDING*

**The Open University, Department of Engineering and Innovation, Milton Keynes, MK7 6AA, United Kingdom.*
***The Open University, Department of Environment, Earth and Ecosystems, Milton Keynes, MK7 6AA, United Kingdom.*

The evolution of greenhouse gases (GHGs) from waste treatment processes (e.g. landfill & composting) are well documented (Chen and Lin, 2008), frequently quantified (Lou and Nair, 2009) and currently represented within climate change models (Ciais et al., 2013). Conversely, the understanding of GHG emissions from household waste (pre-collection) is largely unknown and confined to composting studies (e.g. Andersen et al., 2010), or calculating the calorific value/elemental content (Komilis et al., 2012) and biological methane potential (Alibardi and Cossu, 2015) of municipal solid waste. Generating a better understanding of GHG fluxes from non-recycled residual household waste before collection may help to further refine climate models and inform policy makers regarding the best collection strategy to mitigate GHG emissions.

The following scientific aim was therefore formulated to address this knowledge gap:

- In a laboratory environment establish if the GHGs of methane (CH_4), carbon dioxide (CO_2) and nitrous oxide (N_2O) are emitted from simulated non-recyclable residual household waste bins.

This aim included three objectives:

1. Quantify the influence of temperature on GHG bin emissions
2. Determine the effect of loose vs. bagged waste on GHG emission
3. Ascertain whether closed wheeled bins emit GHGs

To address these objectives a total of 24 wheeled bins (240 L) were used in a single randomised factorial experiment. Each bin was filled with 4.5-5 kg of a typical households non-recyclable residual waste (Parfitt and Bridgewater, 2010, Table 1) once a week for four weeks. This was followed by a further 4 weeks of storage to mimic a missed collection (4 week cycle). 12 of the bins were placed in a refrigerated cold room (0-5 °C) and 12 of the bins within a heated room (25-30 °C). Within each temperature treatment the bins were further split into two treatment groups; waste that was added to the bins loosely and waste that was added within plastic bin bags, i.e. 6 × hot loose, 6 × hot bagged, 6 × cold loose, 6 × cold bagged.

Table 1 Composition of waste added to the bins

Category	Percentage (%)
Food waste	25
Garden waste	15
Paper	20
Plastics & plastic film	15
Card	15
Metals	4
Sanitary materials	3
Textiles	3

CH_4, CO_2 and N_2O were randomly measured from all the bins once a week (spread over two days) over the eight week experimental period. A bespoke rectangular prism (1×1×2 m) flux chamber was constructed from non-gas permeable plastic film, complete with circulating fans, an atmospheric pressure and temperature probe (C4141 Commeter), and gas sample ports. CH_4 and CO_2 were measured using cavity enhanced absorption (Los Gatos – Ultraportable Greenhouse Gas analyser). N_2O was measured using an infra-red gas analyser (Teledyne GFC-7002E). A closed-loop sampling method was used to measure closed lid bin fluxes and open lid bin fluxes for 10 minutes each.

Results from this experiment are currently being analysed and would be presented in full at conference. It is clear from a preliminary examination of the data that the GHGs of CH_4, CO_2 (Figure 1) and N_2O (data not shown) were all emitted from the simulated non-recyclable residual household waste bins at different rates over the eight week experimental period. Figure 1 shows the raw data of average CH_4 and CO_2 fluxes from the four treatment groups over the eight week period. Whilst there appears to be a difference between some of the treatment groups, a robust statistical examination (repeated measure ANOVA) needs to be undertaken to verify this.

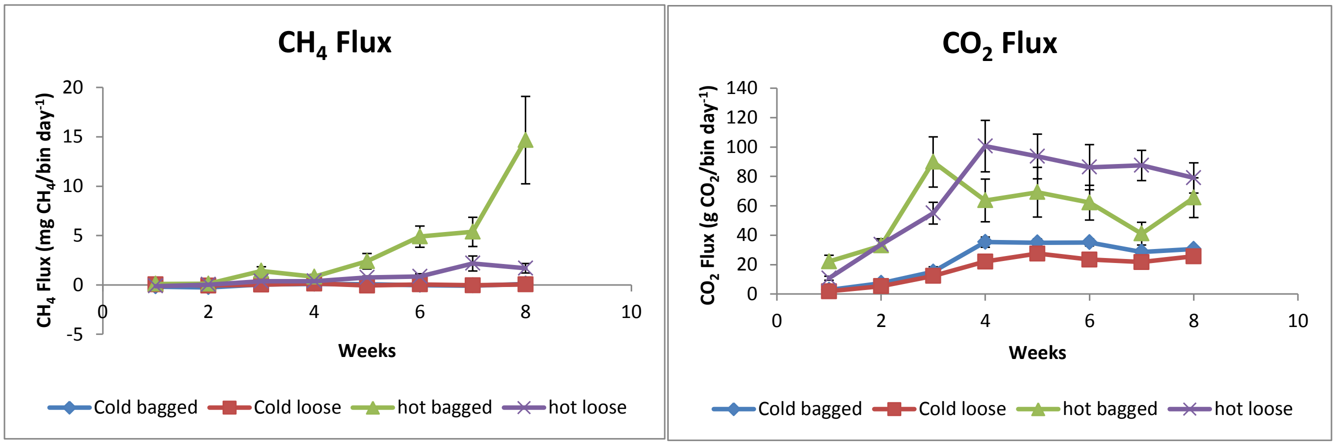

Figure 1 Average single-point CH_4 and CO_2 fluxes from wheeled bins containing non-recyclable residual waste. Error bars represent ±1 standard error of the mean.

Results from this study will be cautiously up-scaled to estimate the GHG flux from residual waste bins at the national and international level to determine their significance in a global carbon cycle context. Findings will also be examined using a waste processing life cycle assessment model to help local councils and waste collection service providers further understand the GHG significance of waste collection frequency.

References

ALIBARDI, L. & COSSU, R. 2015. Composition variability of the organic fraction of municipal solid waste and effects on hydrogen and methane production potentials. *Waste Management,* 36**,** 147-155.

ANDERSEN, J. K., BOLDRIN, A., CHRISTENSEN, T. H. & SCHEUTZ, C. 2010. Greenhouse gas emissions from home composting of organic household waste. *Waste Management,* 30**,** 2475-2482.

CHEN, T.-C. & LIN, C.-F. 2008. Greenhouse gases emissions from waste management practices using Life Cycle Inventory model. *Journal of Hazardous Materials,* 155**,** 23-31.

CIAIS, P., SABINE, C., G., B., BOPP, L., BROVKIN, V., CANADELL, V., CHHABRA, A., DEFRIES, R., GALLOWAY, J., HEIMANN, M., JONES, C., LE QUÉRÉ, C., MYNENI, R. B., PIAO, S. & THORNTON, P. 2013. *Carbon and Other Biogeochemical Cycles. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

KOMILIS, D., EVANGELOU, A., GIANNAKIS, G. & LYMPERIS, C. 2012. Revisiting the elemental composition and the calorific value of the organic fraction of municipal solid wastes. *Waste Management,* 32**,** 372-381.

LOU, X. F. & NAIR, J. 2009. The impact of landfilling and composting on greenhouse gas emissions – A review. *Bioresource Technology,* 100**,** 3792-3798.

PARFITT, J. P. & BRIDGEWATER, E. 2010. Waste 2010: municipal waste composition: what is still in the residual bin and what can we get out? . *Waste 2010 Conference, Stratford-Upon-Avon, UK, 28–29 September.*