



Source segregation and food waste prevention activities in high-density households in a deprived urban area



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ABSTRACT

A waste audit and a household questionnaire survey were conducted in high-density housing estates in one of the most economically and socially deprived areas of England (Haringey, London). Such areas are under-represented in published research. The study examined source segregation, potential participation in a food waste segregation scheme, and food waste prevention activities in five estates (1034 households). The results showed that: contamination of recyclables containers was low; ca. 28% of the mixed residual waste's weight was recyclable; food waste comprised a small proportion of the waste from these residents, probably because of their relatively disadvantaged economic circumstances; and the recycling profile reflected an intermittent pattern of behaviour. Although the majority of respondents reported that they would participate in a food waste separation scheme, the response rate was low and many responses of "don't know" were recorded. Municipalities committed to foster improved diversion from landfill need to recognise that there is no "quick and easy fix", regardless of local or national aspirations. Lasting and sustained behaviour change requires time and the quality of service provision and associated infrastructure play a fundamental role in facilitating residents to participate effectively in waste management activities that maximise capture of source-segregated materials. Populations in deprived areas that reside in high-rise, high-density dwellings are "hard-to-reach" in terms of participation in recycling schemes and exceptional efforts and additional resources are usually required to improve performance.

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1. Introduction

As the global urban population expands, urban areas come under increasing pressure to house more people. In the UK, the process of urban densification is likely to increase as new properties make the most use of land (Timlett and Williams, 2009). Higher urban densities imply a structural shift towards smaller types of dwellings, which reduces the capacity of people and dwellings to cope with domestic waste and recycling (Boyko and Cooper, 2011), and challenges the design of "zero waste" cities (Zaman and Lehmann, 2011).

By 2020 the UK is expected to recycle 50% of household waste and to reduce the biodegradable municipal waste being landfilled to 35% of 1995 figures (DEFRA, 2011). In the last 15 years these targets have forced Local Authorities (LAs) to implement strong measures to improve their approach to waste management in order to comply with legislation, including the Waste and Emissions Trading Act, the Household Waste Recycling Act, and the Landfill

Tax. Currently 43% of household waste in England is recycled or composted (DEFRA, 2012b). In the UK recycling (i.e. source sorting at a household level) and separately disposing of different waste materials (Dahlén and Lagerkvist, 2010), remains voluntary.

The reasons for food waste generation in developed countries are now reasonably well established (see e.g. Lebersorger and Schneider, 2011; EC, 2011). Europeans and North-Americans waste 95–115 kg of food per year per person (FAO, 2011). Food waste is generated before, during or after meal preparation in the household, and in the manufacture, distribution, retail and food service activities (EC, 2011). Household food waste may be classified into 'avoidable' (leftovers, whole unused and part consumed food, including food in its packaging) and 'non-avoidable' (preparation residues) (Lebersorger and Schneider, 2011).

UK food waste currently amounts to ca. 15 million tonnes per year. Households generate ca. 7.2 million tonnes per year of which 61% is avoidable (DEFRA, 2012a). Food waste represents 17% of municipal waste (DEFRA, 2009) and ca. 30% of household waste. Several LAs in the UK have introduced weekly household food waste collection systems; ca. 4 million (16%) UK households received a food waste collection service in 2011 (DEFRA, 2012a).

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Knowing the real quantities and characteristics of material output in waste collections is crucial to appraise recycling efficiency and overall waste management (Dahlén and Lagerkvist, 2010). Waste Disposal Authorities use waste audits (composition analyses) to inform the design, planning and management of future approaches as well as to inform on-going improvements and trends (ENTEC UK Ltd., 2010), including the monitoring of food waste arisings (WRAP, 2011b).

Recycling research has tended to focus on single-family dwellings in low population density areas where kerbside collection systems are relatively easy to implement (Miafodzyeva and Brandt, 2013). Although psychological models have been used to explain householders' recycling behaviour and motivations (Miafodzyeva and Brandt, 2013), research appertaining to influences on food waste segregation behaviour on food waste prevention is limited. Furthermore, few studies have focused specifically on the recycling habits of residents of high-rise dwellings (Williams and Timlett, 2006; Timlett and Williams, 2009, 2011; Lebersorger and Schneider, 2011) in deprived areas, where, potentially, limits to recycling may exist by virtue of practical, situational and perceived barriers.

This study was based in the London Borough of Haringey (LBH), one of the most economically and socially deprived areas in England (DCLG, 2011) and a very challenging area for a research team to access. It examined source segregation, potential participation in a food waste segregation scheme and food waste prevention activities in five selected Local Authority housing estates (1034 households). The study evaluates the results of a survey conducted in the estates before the implementation of a trial food waste collection scheme and analyses the results of a waste audit of a sample from one of these estates. The objectives of the study were to:

- Examine householders' attitudes, motivations and behaviours towards recycling, potential food waste segregation and prevention activities.
- Quantify the waste arisings from residents of high-density housing in an economically and socially deprived area.
- Identify the effects of the current recycling scheme in terms of the materials being recycled and disposed of.
- Suggest possible strategies of action to increase recycling rates in such communities.

The novelty in this work is the focus on the recycling habits and food waste prevention activities in a highly deprived community in a high-density area. A key driver for the study was to provide an evidence-base for policymakers to contextualise the waste management practices in these communities; by greater understanding of waste arisings, motivations, behaviours and barriers to prevention and recycling, it may be possible to redefine communication strategies, service provision and infrastructure through a rational allocation of limited resources.

2. Methodology

2.1. Area of study

The LBH is in the North London region (Fig. 1a). In 2011, LBH had 253,236 habitants living in 101,955 households. Almost half of its population lives in flats, maisonettes or apartments (ONS, 2013). The household recycling and composting rate in 2008/09 was 22.5%; for comparison, it was 29.2% in London (WasteDataFlow, 2013) and 37.6% in England (GLA, 2013b). In 2012, London's figures were 34% (GLA, 2013b) and Haringey ca. 32% (Haringey Council, 2013).

The LBH, as a Waste Collection Authority, delivers collected waste to the North London Waste Authority (NLWA) either for incineration with energy recovery or landfill disposal. It provides estates with recycling facilities where residents can dispose of their recyclables and their mixed residual waste (including food waste) in bring-banks equipped with multiple 1100 l bins for each waste stream. Recyclables include paper, cardboard, drink cartons, plastic bottles, plastic pots, tubs and trays without film plastic, tins and cans, glass bottles and jars.

In 2012 the Council applied for the Weekly Collection Support Scheme funded by the UK's Department for Communities and Local Government. They obtained £682,600 to support weekly residual collections to 25,000 properties (flats) and to launch a weekly food waste collection, providing householders with kitchen caddies and liners (Haringey Council, 2013). Before full implementation, a trial phase was to be introduced in late 2013 in five Council estates (1034 households) managed by 'Homes for Haringey' (the organisation that manages Haringey's Council housing), which are geographically distributed throughout the Borough (Fig. 1b). These estates are classified as ACORN¹ Class 5, group P, Urban Adversity, Struggling Estates; four are Type 54 (Multi-ethnic Purpose Built Estates) and one Type 55 (Deprived and Ethnically Diverse in Flats). ACORN is a consumers' geo-demographic segmentation tool which categorises the UK's population into 62 demographic types according to a combination of government data and consumer research data (CACI Ltd., 2013). It is based on the concept that areas with similar demographic and social characteristics tend to share common lifestyles and patterns of consumption behaviour.

2.2. Data collection

2.2.1. Waste audit

There is no single standardised methodology to carry out a waste audit. For theoretical reasons, we decided to follow Dahlén and Lagerkvist's (2008) recommendations in the context of what was possible for us to audit in a challenging environment. A minimum of 500 kg was selected because the authors consider it is a manageable yet suitably large quantity of waste for manual sorting on a single sampling occasion. For practical reasons we estimated the volume of each waste stream and calculated the weight by multiplying it by the density (Zhang, 2011). Although this methodology introduces uncertainty to the results, it is frequently used in situations that require a time-limited assessment.

Three bins of 1100 l of recyclables and six bins of 1100 l of mixed residual waste from one of the estates (225 households, ca. 22% of the total households) were especially supplied for the task, providing the minimum of 500 kg that Dahlén and Lagerkvist (2008) suggest. The waste was exclusively collected for the task and directly transported from the estate to the study location (NLWA's transfer station) without being compacted. The recyclables bins' content was unloaded on the floor of a tipping bay of ca. 40 m² and the content of the mixed residual bins was unloaded on the floor of another identical tipping bay. The waste collected represented materials disposed by householders from the estate over the previous week.

2.2.1.1. Sorting nomenclature in the waste audit. The recycling bins' contents were classified into 'paper', 'cardboard', 'drink plastic bottles', 'milk plastic bottles', 'other plastics', 'metal containers', 'glass' and 'miscellaneous', while mixed residual waste bins' content was classified into 'paper and cardboard', 'plastic containers', 'other plastics', 'metal containers', 'food waste', 'glass', 'garden', 'construction & demolition' (C&D), 'textiles', 'waste electrical and electronic

¹ ACORN stands for "A Classification of Residential Neighbourhoods".



Fig. 1a. Location of the London Borough of Haringey in the Greater London Region and the North London Boroughs. Source: GLA (2013a). Contains Ordnance Survey data © Crown copyright and database rights 2011.

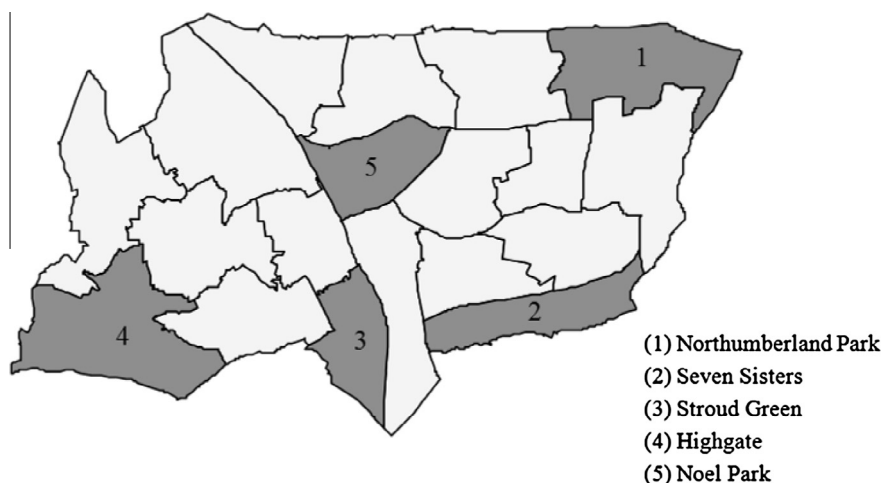


Fig. 1b. Wards in the London Borough of Haringey where the Council Estates were selected to introduce food waste collection trials. Source: GLA (2013a). Contains Ordnance Survey data © Crown copyright and database rights 2011.

equipment' (WEEE) and 'miscellaneous'. The 'food waste' included food in its packaging, according to Lebersorger and Schneider (2011).

2.2.1.2. Sorting procedure in the waste audit. The team started with recyclables; each type of material was separated on the floor and the volume was estimated. Then the team sorted the mixed residual waste in the second tipping bay. The content was sorted as defined and the volume estimated, except for the food waste component, which was put into a plastic bag and weighted with a digital hanging scale. The data were recorded and digital photographs were taken for corroboration of the estimations (Figs. 2a–8).

2.2.2. Household survey

The survey sample included the five estates selected by the LBH's authorities to introduce the food waste collection trial scheme; these included 1034 households. A self-reporting postal questionnaire was designed to be answered by one member of

the household. A freepost return envelope was provided and a prize draw was offered to increase the response rate. Each household received the survey with a covering letter explaining the objectives of the study. In order to identify the origin of the reply (by estate), the survey forms were printed on different coloured paper.

The questionnaire had three sections: the first included nine closed questions to ascertain recycling behaviour and the level of satisfaction with the waste collection service; one open question provided reasons for the level of satisfaction. The second section contained two closed questions to record if the household would separate food waste and to identify any food waste prevention activities. The third section included closed questions to characterise the household. The design of the questionnaire built upon previous studies (Berglund and Matti, 2006; Caswell, 2008; Timlett and Williams, 2009; Stefan et al., 2013). The survey's design was agreed with representatives from the LBH and 'Homes for Haringey'.

2.3. Analysis of the information

2.3.1. Waste audit

The mass and volume proportions of the different materials were calculated and the former was compared with previous household composition studies in the UK and with a recent composition analysis in Haringey, which was part of a wider NLWA study.

2.3.2. Household survey

Data were analysed using SPSS 20 (IBM Ltd). The socio-demographic variables were compared with the Census 2011 data for the LBH. Non-parametric tests were applied to analyse:

- Differences between estates in the frequency of recycling (Test: Kruskal–Wallis; Null Hypothesis: observed differences in the recycling frequency in each estate are not significant with a confidence level of 95%).
- Differences between “frequent recyclers” and “infrequent/non-recyclers” in the terms of their intention to participate in the food waste segregation scheme. “Frequent recyclers” were defined as households that recycle at least once every two weeks. “Infrequent/non-recyclers” were households that recycle less than once every two weeks, do not recycle or do not know how often they recycle (Test: Mann–Whitney *U*; Null Hypothesis: observed differences in the response to food waste segregation in each recycling profile are not significant with a confidence level of 95%).
- Differences between “possible-food-waste-segregators” and “non-food-waste-segregators” in the motivations to recycle. “Possible-food-waste-segregators” were defined as households that would segregate food waste if the service was provided. “Non-food-waste-segregators” were households that would not participate or do not know if they would participate (Test: Mann–Whitney *U*; Null Hypothesis: observed differences in the response to the motives to recycle in each food waste segregation profile are not significant with a confidence level of 95%).

The non-parametric Spearman correlation coefficient was calculated to analyse whether potential participation in the food waste segregation scheme was correlated to the stated motivations to recycle.

The opinions stated about the collection service were coded by topic (Richards, 2005), according to the issues mentioned in the open question. After reading all the responses, topics were identified, grouped and coded, then inserted as a dummy variable in the database for each case.

3. Results

3.1. Waste audit

The waste audit was conducted in June 2013 by a team of four. A total weight of 522.5 kg was audited, 15% of which was the ‘recyclables’ stream and 85% was the ‘mixed residual waste’ stream. The total recyclables’ volume and 65% of mixed residual waste’s volume was audited (Table 1) (Fig. 2a and b).

The three 1100 l bins of recyclables were not full; the overall volume was equivalent to only one 1100 l bin. The contents of the recyclables bins were typically clean; the bottles and the cans had been rinsed prior to disposal. The proportion of non-targeted materials in the recyclables bins was not substantial (3% by weight, Table 1), only some wires, a few textiles, a piece of food, two ceramic items and three medical items were found as contaminants (Fig. 3).

Many recyclable materials were present in the mixed residual waste stream. Paper and cardboard were clean with a relatively low rate of contamination by other materials, probably by the compression of the mixed bags (Fig. 4a and b). There were aluminium cans, two 5 l olive oil cans and a big piece of laminated metal. Textile materials included clothing, a big carpet, and shoes. Some small WEEE such as cabling, a fan and a toaster were found (Fig. 5). C&D waste was composed of plasterboard, bricks, and pieces of wood (Fig. 6). The garden waste material appeared relatively fresh (Fig. 7). About a third of the volume of the miscellaneous materials comprised nappies, the rest comprising plastics, paper and cardboard highly contaminated by food waste, tissues, cigarette butts, dirt and other fines and unclassified materials. Food waste was mostly avoidable, since the majority was take-away leftovers, food items past the best-before/use-by date (i.e. mouldy bread, rotten vegetables), plus vegetable peelings, among other unidentifiable items (Fig. 8).

The amount of paper/cardboard and plastics was higher in the mixed residual waste stream than in the recycling bins. The rest of the materials were mostly disposed of in the correct bin, although metals were disposed of in both types of containers in similar quantities.

3.2. Household questionnaire survey

The survey was hand-delivered during July 2013 to 1001 of the 1034 households. A total of 54 responses were received by late August 2013, however, only 51 were valid responses, representing a 5.4% response rate.

In comparison with the LBH population (2011), there was an over-representation of single person households and an under-representation of households of three or more members. There was also an over-representation of people >45 years old. The respondents were typically stable residents of these properties as 87% had been living there for >3 years. The respondents were mainly of “White British” and “Black” ethnicity (Table 2).

Half of the respondents (51%) claimed to dispose of mixed residual and recyclable waste more than once a week. Most of the respondents (80%) declared themselves as frequent recyclers, while 10% were self-reported non-recyclers and the rest said they recycle infrequently or did not know how often they recycled. The most recycled material was glass as it was reported by 84% of respondents. The ranking of materials by frequency of recycling is shown in Table 3.

Approximately one-third of respondents (36%) felt that nothing prevents them from recycling more. The remainder indicated at least one barrier to recycling; 33% were infrequent or non-recyclers. The four most frequently mentioned barriers (Table 4) were a (perceived): lack of bins to recycle, lack of space at home to store recyclables and, in equal proportions, lack of information about the scheme and ‘other barriers’, such as a lack of bins to recycle other materials (e.g. textiles, electrical equipment, batteries, etc.) or restrictions to vans in the recycling centre.

The majority of people said they used the recycling bins on the estate to recycle. Few respondents mentioned they make use of a reuse and recycling centre, and none of the respondents indicated that they used other bring sites (e.g. in supermarkets) to recycle.

While 84% of respondents declared they feel a moral obligation to recycle, only 57% considered that it made them feel good. When asked if they recycle to portray themselves to others as responsible individuals, only 37% agreed, although 63% of people said they recycle to think of themselves as a responsible person. When asked if they recycled to make others recycle, opinion was divided. However, when asked if the Council was a decisive factor that motivates residents to recycle, respondents equally agreed and disagreed (25%) but many (33%) had a neutral view. While 71% of

Table 1

Volume, mass and percentages of different materials found in the mixed residual waste and recyclables bins during the waste audit.

	General waste				Recyclables			
	vol (L)	mass (kg)	% vol	% mass	vol (L)	mass (kg)	% vol	% mass
Cardboard	1200.0	78.6	32	18	350.0	19.3	31.0	24.0
Paper					250.0	19.0	22.0	23.0
Milk bottles	400.0	28.8	11	6	19.0	1.4	2.0	2.0
Drinks bottles					70.0	5.0	6.0	6.0
Other plastics	250.0	8.5	7.0	2.0	350.0	11.9	31.0	15.0
Glass	6.6	3.0	0.0	1.0	40.0	18.2	3.5	23.0
Metals	40.0	2.5	1.0	1.0	50.0	3.2	4.0	4.0
Food waste	130.4	37.8	3.0	8.0	0.7	0.2	0.0	0.0
Garden	150.0	13.7	4.0	3.0	0.0	0.0	0.0	0.0
Textiles	250.0	22.8	7.0	5.0	4.4	0.4	0.0	0.5
WEEE	80.0	8.4	2.0	2.0	0.0	0.0	0.0	0.0
C&D	250.0	131.9	7.0	30.0	0.0	0.0	0.0	0.0
Miscellaneous	1000.0	106.0	26.0	24.0	6.0	2.0	0.5	2.5
Audited	3755.0	442.0	–	–	1140.1	80.5	–	–
Non audited	2000.0	–	–	–	0.0	0.0	–	–
Total	5755.0	–	–	–	1140.1	80.5	–	–
Max	6600.0	–	–	–	3300.0	–	–	–

**Fig. 2a.** Recyclable waste bins' content to be audited, prior to start the task, as received by the auditing team.**Fig. 2b.** Mixed residual waste bins' content to be audited, prior to start the task, as received by the auditing team.

respondents disagreed with the idea that they do not need to recycle as enough is done by others, 14% of respondents agreed with or had neutral opinion to this statement. Finally, 84% of respondents felt they should not waste if things can be reused.

Sixty-five percent of residents thought that recyclable materials segregated at home are taken to a facility to be further separated and recycled but 22% did not know the fate of the materials they segregated at home. Other respondents considered recyclables were either reused (6%), landfilled (2%) or that they had another destination.

Residents indicated that the Council's magazine is the most used medium to receive information about recycling services (mentioned by 51% of respondents); posters seemed to be informative but to a lesser extent.

With respect to the collection arrangements provided by the Council, 65% of respondents were satisfied, 17% were neither satisfied nor dissatisfied and 18% were dissatisfied or did not reply. Only 47% of residents that were satisfied perceived no barriers to recycle while 88% of dissatisfied residents felt that there is at least one barrier preventing them from recycling more.



Fig. 3. Non-targeted materials in the recyclables bins.

Some 59% of the respondents clarified the reasons for their opinion. Most of them considered that the collection frequency (for the communal bins on their estate) is appropriate as it is more than once a week, although it was mentioned that they do not have enough information about the scheme. Some residents considered the system easy and convenient to use while others believed that recycling bins and frequency of collection are insufficient.

A majority of residents (61%) were willing to separate food waste if they were provided with a kitchen caddy and a communal bin, although 22% did not know. Moreover, 38% of frequent recyclers answered they would not participate or did not know if they would. Almost half of the residents who perceived a barrier to recycling were (potential) “non-food-waste-segregators”. With respect to the food waste prevention activities’ householders conducted, in some cases the non-response rate was as high as 27% (Table 5).

The frequency of recycling within the different estates was not significantly different ($\chi^2 = 4.282$; $p = 0.369$). The differences

in the response to food waste segregation between “recyclers” and “infrequent/non-recyclers” were not significant ($U = 195.000$; $Z = -0.144$; $p = 0.914$).

The differences in the responses about the motivation to recycle between “possible-food-waste-segregators” and “non-food-waste-segregators” were significant in three cases. Only three motivations showed a significant Spearman correlation coefficient with the intention to participate in the food waste separation scheme (Table 6), although two were weak and one was moderate.

4. Discussion

4.1. Waste audit

Low rates of mis-sorted materials were identified in the recyclables bins’ contents, which may indicate that recyclers are fully aware of how to identify the recyclable materials according to the Council’s instructions, which are clear, simple and easy to follow. This may explain the good quality of these materials.

The proportion of recyclables in the mixed residual waste bins that could have been correctly disposed of in the recyclables bins indicates the level of participation in the recycling scheme. In this study, it was ca. 28% while in other areas of the UK this figure is lower, even in the same ACORN class (Table 7). This observation indicates that residents do not routinely prioritise sorting and storing recyclable materials to later dispose of them in the recycling bins, and this could be due to the barriers to recycle they encounter, a lack of interest, or a lack of knowledge of materials that are recyclable.

The proportions of paper, cardboard and plastics reported in past UK-based studies are similar to those found in the present study. In contrast, the proportion of C&D waste was higher whilst the proportion of food waste was considerably lower than in other studies (Table 8). This difference could indicate that the sample was not “typical” or “representative”, that seasonality interferes in the amount of food waste being generated, or that not much food waste is produced by residents in this type of property, probably because of their relatively disadvantaged economic circumstances. Some consumer behaviour theories explain disposal as a movement of thrift instead of a movement of surplus; this implies



Fig. 4a. Clean recyclable materials in the mixed residual waste (plastics, metals, glass).



Fig. 4b. Clean recyclable materials in the mixed residual waste (plastics, cardboard & paper, metals).



Fig. 5. Textile materials and some small WEEE in the mixed residual waste.

that consuming leftovers, which is a much internalised practice in the household (65% of respondents claimed using these to make meals), maximises thrift (Cappellini, 2009). The control over the use of resources in UK middle-class households is represented in the practice of thrift (Cappellini and Parsons, 2013). Considering

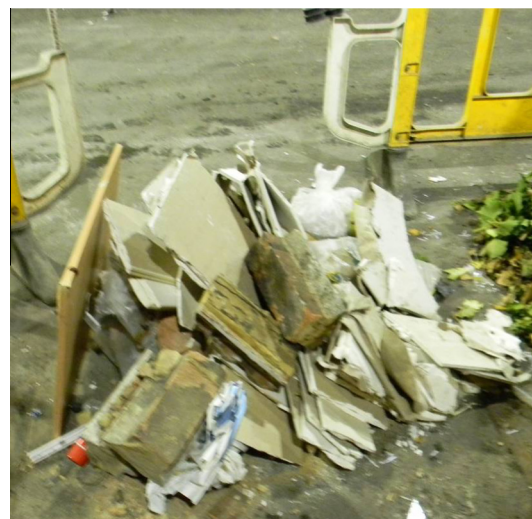


Fig. 6. Construction & demolition materials in the mixed residual waste.

these concepts it may be possible to argue that this situation is accentuated in economically deprived contexts, consequently showing reduced amounts of food waste in their mixed residual waste. Since 2009 there has been a reduction in the household food waste generation in the UK associated with economic recession, combined with rising food prices (WRAP, 2011b), both of which may have been influential in a household's decision to maximise the utilisation of purchased food and to reduce its wastage.

The presence of textiles, C&D waste, WEEE and garden waste indicates that residents may have no other means to discard these materials on the estates. Although the generation of such materials may be occasional, people tend to dispose of them in this way instead of arranging a collection with the Council or using a recycling centre. Probably it is an easy alternative or they do not have access to a recycling centre, either because of the lack of a vehicle or knowledge about its existence. The installation of textile and small WEEE banks on the estates could improve the residents' tendency to recycle these materials. The establishment or the strengthening of partnerships with local charities and third sector organisations for the collection of these materials may result in higher recovery rates (WRAP, 2011a, 2012).

The high proportion of miscellaneous waste indicates it is a broad category that should be subdivided. Since a third comprised nappies (ca. 10% of mixed residual waste), which represents between 15% (ACORN 5 class) and 21% (flat's residents) of residual waste (Widdowson et al., 2012), the UK's WRAP 'Real Nappies for London' campaign could be further promoted to subsidise the up-front costs of choosing "real nappies" to minimise waste and reduce the disposal costs. From the rest of miscellaneous wastes, much could be correctly disposed of as recyclables and the rest as food waste and a small amount as non-recyclables.

If successfully implemented, a separate food waste collection could reduce mixed residual waste arisings by up to 16%. This is considering two aspects; first, that the proportion of food waste in the mixed residual waste was ca. 8% and it was almost insignificant in the recyclable waste. Second, contamination of the recyclable material in the miscellaneous category of the mixed residual waste could be reduced by ca. 8% by minimising contamination by food waste.

4.2. Household survey

The questionnaire return rate was lower than other studies that used the same technique (Bernstad et al., 2013; Williams and Cole, 2013). One-person households, single-parent families, households



Fig. 7. Garden waste in the mixed residual waste.

in central London, ethnic minority families, deprivation levels (Rahman and Goldring, 2006), are associated with households including persons who are poorly qualified or unemployed, within low socio-economic status groups and non-movers (Durrant and Steele, 2009) who tend to be less likely to participate in the UK Census and in other Government surveys. Moreover, the effects of design and topic vary across subgroups of households, which could influence their participation in surveys (Durrant and Steele, 2009). The researched group shares some of these characteristics, which contextualise the low response rate.

There is a tendency to exaggerate self-reported recycling behaviour (Timlett and Williams, 2008) and it is likely that those who are willing to participate in recycling are more willing to complete a questionnaire concerning recycling (Bernstad et al., 2013). Nonetheless, the proportion of respondents self-declared as frequent recyclers (80%) was lower than in other areas (90%: Lyas et al., 2005; Timlett and Williams, 2008; Bernstad et al., 2013). The non-significant differences in the recycling frequency amongst the five estates indicated that the self-reported recycling profiles were similar within the sample.

Intermittent recyclers living in flats tend to perceive that the capacity of facilities available to them for recycling and/or the associated service provision are barriers to participation (Ahmed et al., 2013). This observation corresponds with the respondents' views expressed in the present study; they perceived that a lack of recycling bins prevents them from recycling more. The overall service provision as a barrier is reflected in the negative opinions about the collection arrangements since an insufficient number of recycling bins and an inadequate collection frequency were mentioned. Taken together, these factors indicate that although respondents declare themselves as frequent recyclers, their opinions fit the profile of less frequent – intermittent – recyclers. This aspect, and the fact that half of frequent recyclers perceived a barrier, could also explain the lower proportion of declared recyclers.

Intermittent recyclers tend to lack of emotional engagement in the social and environmental reasons for recycling; they do it because the Council requires it instead of being proactive to overcome the barriers to recycling (Ahmed et al., 2013). Regular recyclers typically participate because they are morally driven and because they look for a sense of responsibility in their own self-image. Only 25% agreed with the idea that they recycle because the Council expects them to, which contrasts with other studies in which 56% agreed with the same statement (e.g. Berglund and Matti, 2006), whereas the majority felt they should not waste if they can be reused, and considered they need to recycle as not enough is done by others. These motivations stress the importance of personal moral norms and indicate that a highly internalised attitude governs individual recycling behaviour (Miafodzyeva and Brandt, 2013).

Although 10% of respondents were self-declared non-recyclers, the lack of interest in recycling was not widely identified as a barrier to recycling. 'Aware but inactive' or 'contemplated but not engaged' recyclers (Ahmed et al., 2013), who are presumably not interested, may not be well represented on the survey because of the low response rate, which generally demonstrates a lack of interest in recycling (Bernstad et al., 2013).

Insufficient space at home to store recyclables was the second most frequently mentioned barrier; this observation corresponds with findings of other studies (e.g. Oates and McDonald, 2003; Timlett and Williams, 2009), particularly in high-density dwellings. Some individuals might be likely to report that they do not



Fig. 8. Food waste.

Table 2
Demographic composition of respondents compared to Haringey's demography.

	n	%	Haringey (%)
<i>Household size</i>			
One	23	49	37
Two	14	30	24
Three or more	10	21	39
<i>Age</i>			
0–4	3	4	7
5–17	8	9	16
18–24	13	15	10
25–44	20	24	39
45–64	25	29	20
65+	16	19	9
<i>Sex</i>			
Female	47	52	51
Male	44	48	49
<i>Time of residence</i>			
Less than a year	1	2	N/A
Between 1 and 3 years	5	11	N/A
More than 3 years	41	87	N/A
<i>Ethnicity</i>			
White: English/Welsh/Scottish/Northern Irish/British	21	46	35
Other White background	4	9	26
Mixed/multiple ethnic groups	3	7	6
Black/African/Caribbean/Black British	12	26	19
Asian (Indian/Pakistani/Bangladeshi)	1	2	5
Asian (Chinese/Other ethnic group)	2	4	5
Other (please specify)	3	7	5

have adequate space to recycle if they are generally disinclined to recycle (Ando and Gosselin, 2005), and in some cases this could be a genuine restriction considering the limited spaces where these residents live.

Although several respondents reported not having enough information about the scheme, this does not imply that the Council is inactive because those who recycle are doing it according to what the Council expects from them. This observation arises from the audit since recyclable materials were correctly discarded in the main, and also the survey: most respondents stated they were informed about the destination of the recyclables. Therefore, it could be argued that residents exaggerate “lack of information” as a barrier instead of recognising they do not give full attention to information provided.

Residents affirmed they mostly recycle glass, paper and cardboard. In terms of weight, this coincides with the audit as these three materials comprised 70% of mass of recyclables materials. But in terms of volume, paper and cardboard represented 50% of recyclables while glass was not significant. This observation indicates that either glass is recycled elsewhere (e.g. bring-banks) or that residents identify it as a recyclable material without this implying a real action or being recycled as frequently as stated.

Table 3
Ranking of recyclable materials according to what the residents identified as the materials they recycle.

Materials	Number of cases mentioned
Glass bottles and/or jars	42
Paper and/or cardboard	39
Plastic bottles	36
Food tins and/or cans	33
Plastic tubes and containers	31
Drink cartons	28
Other	8
None	4

Table 4
Ranking of barriers to recycling stated by the residents as the ones they perceive.

Materials	Number of cases mentioned
Lack of bins to recycle	15
Not enough space at home to store recyclables	9
Other	4
Lack of information about the scheme	4
The process is too complicated	3
Not enough time to recycle	3
Lack of safety at the bring sites on the estate	2
Lack of interest in recycling	2

Furthermore, 38% of the total audited waste by weight (ca. 200 kg) was “recyclable” but only 15% was correctly disposed of in the recyclables bin, while in the mixed residual waste ca. 28% was recyclable. These figures demonstrate that recycling participation is over-self-reported and only through compositional analyses is it possible to validate information and waste trends.

The presence of textiles, garden waste and WEEE in the mixed residual waste stream during the audit is related to the perception of ‘other barriers’ to recycling, i.e. the lack of bins to recycle such materials, since some residents opined that there is a lack of collection services for other wastes and bulky waste on the estates.

Most of the respondents knew the destination of the recyclables once collected, which reveals that they are correctly informed about the system's operation. However, almost a quarter of the respondents did not know. Making residents familiar with what happens with the recyclables is a crucial feature of recycling communication campaigns because it connects the efforts of the household and the LA. This connection can create a sense of trust in the system, but it needs to be supported not only with informative messages but also with a good service provision to sustain the trust in the system and to avoid generating ideas such as “everything ends up in a landfill” (e.g. Lyas et al., 2005) or “recyclables are given to private contractors for their own benefit”. It is important for LAs to show the work they do and the costs they face to provide the recycling service, because these are hidden for the majority of the households (Bulkeley and Gregson, 2009).

The LBH Council magazine was the most used source of information. In other studies leaflets have been used and well received by the public to be informed about recycling services (Timlett and Williams, 2008). The magazine was used to communicate appropriate details and to address different types of recyclers more specifically. Posters also seemed to be informative although they do not provide direct messages. Posters could be used for general information and to provide feedback about the comparative performance either of the LA or the neighbourhood, or even about the latest improvements in recycling. Stressing the importance of residents' efforts via posters could engage some householders, particularly non-recyclers (Williams and Culleton, 2009; Timlett and Williams, 2008). Messages of this ilk delivered via leaflets may well prove to be ineffective (Lyas et al., 2004).

The level of satisfaction with the collection arrangements was considerably lower (65%) than in other areas, where it is often over 90% (e.g. Williams and Cole, 2013). Only five topics sustained positive opinions about the service provision. In contrast, the neutral or dissatisfied residents gave a wider range of reasons (nine) for their opinions.

Although fortnightly residual waste collection can favour recycling (Williams and Cole, 2013), most respondents in this study perceived the best feature of the system to be the high frequency of collection; some even held a negative opinion of the collection frequency believing it was not high enough.

Other negative opinions about the service were related to the condition of the bring sites on the estates. Some residents

Table 5
Level of agreement to performing waste prevention activities by respondents.

Shopping routines	"We buy the amount of food that we know we need"	67% agreed
	"We check the use-by/best-before date when doing the shopping"	67% agreed
	"We split purchases of food on offer with friends or relatives"	45% disagreed and 12% were neutral (27% did not respond to this question)
	"We buy the food we intended to buy before going to the market"	45% agreed and 23% were neutral
Planning routines	"We plan meals in advance for several days before"	31% agreed and 29% disagreed
	"We make a list of the food we need before going to the market"	49% agreed and 16% were neutral
	"We check the food we have at home before we go to buy food"	67%
Behavioural control	"We cook exactly the amount of food that our family needs"	59% agreed
	"We take care to store food items in order to make them last longer"	78% agreed
	"We freeze perishable food such as milk, bread, meat, etc"	51% agreed
Reuse	"We use leftovers to make meals"	65% agreed

indicated "poor maintenance", "fly-tipping" and a "presence of scavengers" as reasons for their negative opinion, the latter of which was corroborated in the fieldwork, and could have been either human or animal. These conditions may discourage householders from recycling since the infrastructure does not encourage participation. When analysing which factors influence a LA's ability to meet realistic recycling rates it must be considered that the infrastructure and the service provision both have important effects on recycling behaviour patterns (Timlett and Williams, 2011). Removing the barriers associated with the infrastructure and service provision provides a starting point to enhance participation.

Although the majority of respondents reported that they would participate in a food waste separation scheme, the response rate was low and many responses of "don't know" were recorded. There was no clear evidence that recyclers would act differently from infrequent/non-recyclers in this respect. Some frequent recyclers (40%) indicated they would not participate in food waste collection or they did not know whether they would participate. However, the rejection of the food waste caddy does not

Table 6
Motivations to recycle related to the intention to separate food waste.

Motivation	Mann–Whitney test	Spearman <i>r</i> correlation coefficient
"I feel a moral obligation to recycle to contribute to a better environment"	$U = 187.500$; $Z = -2.335$; $p = 0.020$	$r = 0.337$; $p = 0.018$ (weak)
"I do not need to recycle as enough is done by others"	$U = 133.500$; $Z = -2.247$; $p = 0.025$	$r = -0.347$; $p = 0.023$ (weak)
"I feel I should not waste if it can be used again"	$U = 120.500$; $Z = -3.626$; $p < 0.001$	$r = 0.529$; $p < 0.001$ (moderate)

necessarily imply a rejection of the scheme (Metcalfe et al., 2013). Some households may welcome the kitchen caddy whereas others may find it problematic (Evans, 2012). The presence of the caddy can lead people to undertake particular waste practices, since it simultaneously represents waste and the environment together with cultural values about cleanliness, order and pollution (Metcalfe et al., 2013).

To be effective, residents are expected to co-ordinate their domestic practices and to be engaged with the bins to routinely manage waste through them (Bulkeley and Gregson, 2009). Particularly in areas with low recycling levels in deprived communities, it can be a challenge because residents want to keep 'the Council' out of their homes as much as possible. The objects and practices associated with the infrastructure of household waste management which require residents to do special tasks are not easily incorporated because they are understood as enacted for the Council (Bulkeley and Gregson, 2009).

Only the moral motivations showed significant differences between potential and non-food-waste-segregators. This contrasts to Refsgaard and Magnussen (2009) who found that separating food waste is a norm-based activity in Norway.

Food waste prevention is one of the most effective measures to divert biodegradable municipal waste from landfill (Sharp et al., 2010), although it is not clear whether implementing a separate food waste collection necessarily leads to food waste prevention (WRAP, 2010). Campaigns to avoid food waste should be aimed at influencing consumers' practices related to food:

- The way people plan, shop, store, prepare and use food (Stefan et al., 2013; WRAP, 2011b), such as the WRAP's 'Love Food Hate Waste' campaign in UK.
- Avoiding returns, transfer of best practices, information and education, strengthening the donation to social services (Lebersorger and Schneider, 2014).

One half of English households (claim to) plan meals, more than 60% make a shopping list, and over 75% check the food inventories before buying (WRAP, 2011b). These figures differ with the present survey results as only 31% reported planning their meals, 49% claimed they make a shopping list, and 67% checked what they have at home before buying food. Most residents said they do not buy what they intended to despite the fact they considered the amount they know they need. Households routinely provision more food than they can find a use for and generally this excess becomes waste, regardless of the anxiety or guilt when discarding it (Evans, 2011). This could occur because the consumer knowledge of the location and quantity of the food available in the household, the knowledge about how to prepare food and the past experiences that lead the consumer to prematurely dispose of food (Farr-Wharton et al., 2014) are the major behaviours that result in higher amounts of discarded edible food in the household (i.e. avoidable food waste). Most of these residents claimed to cook exactly what is needed for the family (59%) and to store carefully food to make it last longer (78%) (Table 5). It is likely that such behavioural factors in economically and socially deprived households could help explain the low content of food waste in their

Table 7
Percentage of recyclables in the mixed residual waste stream in different UK areas. Source: (Murphy et al. (2012) (1); Wells (2010) (2); Widdowson et al. (2012) (3)). N/A: Not Available.

Region	Overall	ACORN 5
Hounslow ⁽²⁾ (2010)	20	22
Surrey Councils ⁽¹⁾ (2010)	12	-N/A
Greater Manchester ⁽³⁾ (N/A)	21	-N/A

Table 8
Proportion of waste materials (%) in the mixed residual waste for different studies in the UK.

	England ⁽¹⁾ (2006/7)	Haringey ⁽²⁾ (2010)	North London Region ⁽²⁾ (2010)	Hounslow ⁽⁴⁾ (2012)	Surrey Councils ⁽³⁾ (2010)
Paper & cardboard	23	20	21	10	14
Plastics	10	18	17	14	14
Glass	7	9	5	2	4
Metals	4	2	4	2	3
Food Waste	18	28	26	30	29
Garden Waste	14	6	6	1	7
Textiles	3	3	3	4	3
WEEE	2	1	1	1	1
C&D	2	1	1	N/A	N/A
Miscellaneous	18	12	16%	N/A	N/A

Widdowson et al. (2012) (4). N/A: Not Available.

mixed residual waste. Likewise, householders' food purchasing may be influenced by, for example, access to a vehicle (and thus facility to purchase larger quantities of food), ownership of a freezer (about half of the LBH questionnaire respondents freeze food) and space available for food storage, lack of which could account, potentially, for greater planning in food purchasing through the constraints thus imposed. Ultimately, food waste is a consequence of the ways in which domestic food practices are socially organised (Evans, 2011).

The moral or pro-environmental motivations need to be carefully considered with respect to the design of messages intending to make people recycle (Sharp et al., 2010) or reduce their waste arisings, particularly considering that the moral motivations to recycle explored in this study correlated to the intention to separate food waste. Being familiar with the motives that individuals state for their environmental behaviour is essential to construct effective policies which rely on co-operation and engagement from householders (Berglund and Matti, 2006).

4.3. Further steps

Residents in high-rise dwellings are “hard-to-reach” in recycling schemes and this factor often leads to low participation (WRAP, 2008). This notion was corroborated through the waste audit and the levels of recyclables observed in the mixed residual waste together with the low proportion of recyclables in the correct bin. Different sociological theories (see Durrant and Steele, 2009) suggest that participation in government initiatives (surveys in particular) may be hindered by the perception in low socio-economic status groups of having received poor services and being disadvantaged, feeling not bound to participate in or respond to a government request. If this is considered as a barrier for the LA to gain access to residents and is extrapolated to its requirement of sorting waste, low participation in the scheme could potentially be explained in this particular context. A direct approach to promoting recycling in these communities through door-stepping campaigns on a small scale with specific aims and targeted households works effectively to engage residents with the service and increase the range of materials recycled (Timlett and Williams, 2008). Personal, face-to-face contact between LAs and residents in interventions based on ‘personal approach’ may lead to meaningful behavioural changes since residents can re-engage with waste through reconceptualising materials and consequently incorporate waste management responsibilities in their private lives (Bulkeley and Askins, 2009). Persuasive and binding communication strategies are used for behavioural change; the latter considers the actor as a “target” rather than as a passive receiver and is thought to be more effective to result in behavioural changes (Demarque et al., 2013).

After the introduction of separate food waste collection in high density residential areas the amount of residual waste tends to

decrease; those residents who receive verbal information about the scheme through a door-stepping campaign may have higher food waste source-separated ratio and lower ratio of incorrectly sorted material (Bernstad et al., 2013). However, the source-separated ratio decreases over time, which indicates that the impacts of door-stepping campaigns may have low longevity. Awareness campaigns require long term objectives and repetition in order to gain and reinforce support; residents can be reluctant and sceptical when the food waste source segregation is first introduced, but then become positive towards the system (Refsgaard and Magnussen, 2009).

Since high-rise dwellers are “hard-to-reach”, including their views becomes important for policy implementation because certain interventions can only be effective and successful if they are accepted by the majority of the affected people (Welp et al., 2009). Considering the variety of stakeholders involved in these communities and their perception of “the Council” together with other social demands of these groups allows framing their current participation in the recycling scheme and their potential participation in a food waste segregation scheme. This implies a deviation from the traditional approach: participatory decision making takes longer and initially costs more than command-and-control decision making (Williams and Culleton, 2009), which generally does not persist in time or cannot be fully implemented regardless of the amount of funds put into them, which tend to result in net losses, just because of public opposition (Creighton, 2005) or lack of involvement. Participative communication strategies relying on the active involvement of residents to disseminate key information have been demonstrated to result in sustained behavioural change related to waste sorting (Mickaël, 2014) and may be effective in the case of the LBH.

Any intervention in household daily waste practices that pre-supposes individuals are passive and malleable actors is certain to fail (Bulkeley and Askins, 2009). Therefore, before a new food waste collection service in high-rise dwellings with low recycling rates is implemented, a rational approach should consider how to improve current recycling within the limited budget LAs have access to. For example, considering 2011/12 LBH's waste figures (WasteDataFlow, 2013), if 28% of residual waste could be correctly disposed of in the recyclables bins from these 25,000 flatted properties, the LBH Council would avoid the need to dispose of ca. 4600 tonnes/year (656.15 kg/household year × 25,000 households × 28%) and reduce Landfill Tax payments by ca. £260,000 (£56/tonne at 2011/12 fees). This scenario illustrates that by improving the current recycling system through multiple communication initiatives aimed at improving source-sorting performance, costs could be substantially reduced. By comparison, and if successfully implemented, a separate food waste collection could result in a reduction in mixed residual waste of ca. 2600 tonnes/year (656.15 kg/household year × 25,000 households × 16% potential reduction), equivalent to a reduction in Landfill Tax of

ca. £170,000 (£64/tonne at 2012/13 fees). This approximate and simple cost analysis show that the time-constrained use of funds, based on the necessity of meeting targets, may force the adoption of decisions that expect rapid changes in residents without having realistically assessed the system in view of the infrastructural, service and behavioural barriers that these householders encounter (Timlett and Williams, 2011). Based upon these estimates, the introduction of food waste collection in high-density properties in deprived urban areas is probably not the most cost-effective use of funds in the short term. Improvements to the current recycling scheme through different communication and participative strategies sustained with proper service and infrastructures are more likely to contribute to meeting targets in a long-lived and cost-effective fashion.

Future work may aim to improve the representativeness of the composition analysis by conducting a larger number of audits. To encourage participation in the survey of householders, pre-contact with the estates' caretakers and distribution of posters should be sought. Interviews and focus groups may also be conducted and practical experiences developed in further research on mechanisms that could work to engage deprived communities in source segregation of recyclables and food waste sorting at home.

5. Conclusions

This study met its objectives to investigate source segregation, potential food waste segregation and food waste prevention activities of residents in high-rise, high-density dwellings in a challenging and deprived area of London through a survey and a waste audit. The key findings are:

- The estates' residents typically sort materials according to the Council's messages since few materials were contaminating the recyclables containers.
- Since ca. 28% of the mixed residual waste's weight was recyclable, there is scope to improve the identification of materials by householders and their participation in recycling.
- Food waste comprised a small proportion of the waste from these residents, probably because of their relatively disadvantaged economic circumstances.
- There were fewer self-reported recyclers in this study than in other studies in the UK.
- The level of satisfaction with the waste collection arrangements was lower than in other studies in the UK.
- Although the majority of respondents claimed that they would segregate food waste, many recyclers did not know whether they would participate and there was no significant difference between the recyclers and non-recyclers in terms of their intention to participate in food waste collection. Only moral motivations seemed to influence this intention.
- The introduction of food waste collection in high-density properties in deprived urban areas is probably not the most cost-effective use of funds in the short term. Improvements to current recycling schemes through different communication and participative strategies aimed at improving source-sorting sustained with proper service and infrastructures are more likely to contribute to meeting targets in a long-lived and cost-effective fashion.
- LAs committed to using external funds in a limited time-frame to achieve improved diversion from landfill need to recognise that there is no "quick and easy fix", regardless of local or national aspirations. Evidence from this and other studies clearly shows that lasting and sustained behaviour change requires time and that the quality of service provision and

associated infrastructure plays a fundamental role in facilitating residents to participate effectively in waste management activities that maximise capture of source-segregated materials. Populations in deprived areas that reside in high-rise, high-density dwellings are "hard-to-reach" in terms of participation in recycling schemes and exceptional efforts and additional resources are usually required to improve performance.

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