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Citation

Bradley, P.; Thomas, C.; Druckman, A. and Jackson, T. (2009). Accounting for Food Waste: comparative analysis within the UK. Proceedings of the ICE - Waste and Resources Management, 162(1) pp. 5–13.

URL

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Accounting for food waste: comparative analysis within the UK

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Date written 02/03/08

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Key words: commercial and industrial waste, household waste, UK

Abstract

Meeting UK ambitions for reducing waste will require careful planning and informed investment in infrastructure. An essential pre-requisite for both is the availability of robust waste data. This paper compares four methods for estimating food waste in Hampshire, two for businesses and two for households. Firstly, household food waste is estimated from food expenditure data using an expenditure data approach. This is compared against household waste collection data. Next, business waste is estimated by applying Defra published data from the Environment Agency Commercial and Industrial Waste Survey (2002) to the business profile of the hospitality sector in Hampshire. These results are compared with those from the application of a different survey approach to the same business profile.

The research illustrates significant problems in achieving consistent and reliable data, especially for business. It was found that the Environment Agency 2002 survey published data are very likely to underestimate food waste in the Hospitality sector due to the amount of waste that the survey classifies in miscellaneous categories such as mixed or general waste. The findings could apply to other sectors. The paper discusses the implications of these findings, highlighting, in particular an urgent need for the release and publication of current C&I waste data, as well as more robust sector-specific surveys and consistent accounting frameworks.

1. Introduction

The Waste Strategy for England 2007 states that ‘waste is a drag on the economy and business productivity’¹. Businesses in England produced an estimated nearly 68 million tonnes of industrial and commercial waste in 2002-3, of which 41 percent was landfilled and 44 percent was recovered². The total amount of collected municipal waste was estimated to be 29.1 million tonnes in England in 2006/07, of which 58 percent was sent to landfill³.

Food waste is an important component of biodegradable waste in municipal as well as commercial and industrial waste streams. The Environment Agency (EA) estimated food waste arisings for commercial and industrial sources to be 6.2 million tonnes in 2002 and the Waste and Resource Action Programme (WRAP) estimate food waste from households to be 6.7 million tonnes in 2005 - 2006⁴.

Drivers such as the EU Landfill Directive and concern about tackling climate change have increased pressure to change the way in which countries deal with waste. Recent UK waste policy has focused on diversion from landfill, especially for biodegradable wastes. The

government has targets for diversion of biodegradable waste from landfill and for recycling and these targets are stimulating change in waste management practice in the UK. The new national target for reduction of commercial and industrial waste going to landfill published in the Defra Waste Strategy for England 2007 will add another driver¹. Meeting targets and reducing the climate change impacts of waste will require investment in collection and treatment infrastructure. Ideally any consequent expansion and provision of appropriate waste management facilities should depend on accurate data and understanding of the resource flows concerned in order to enable investment to be carried out in the most efficient and effective way. Robustness and detail of current household and business waste datasets is limited.

The aim of this paper is to see what differences occur when comparing different studies of food waste for the same households and businesses within the same local geographic area but using different methods and datasets. Specifically the study compares two methods of estimating household food waste for Hampshire (one developed by the University of Surrey and the other by the Open University and the University of Southampton) and two methods of estimating food waste in the Hospitality sector of Hampshire (again one developed by the University of Surrey and the other by the Open University and the University of Southampton). The Hospitality sector includes all businesses classified as Standard Industrial Code (SIC) 55 Hotels and Restaurants.

The paper is organised as follows. Background to the paper is provided in section 2. In section 3 the four methodologies are described. Section 4 presents the results from each methodology as applied to the case study areas and contrasts the results. The synergies and differences are discussed in Section 5. In the final section (Section 6) findings are summarised and conclusions drawn with some policy recommendations for improvements to waste arisings data.

2. Background

Local authorities have a duty to collect household waste. Businesses are responsible for arranging the collection and disposal of their own waste¹. In the 2007 Waste Strategy however, Government encourages local authorities to use their role as local community leaders in partnership with business, other local, sub-regional and regional public sector organisations and third sector organisations to achieve a more integrated approach to resources and waste in their area. The Waste Strategy 2007 also recommended that regional development agencies should develop and improve their understanding of the waste and resource efficiency needs of business at a regional level, and ensure that these are reflected in regional economic strategies and regional spatial strategies.

With regard to data available to aid decisions on waste infrastructure, regional resource and waste management planning, municipal and household waste data are reported on in England by Defra (Department for Environment, Food and Rural Affairs). Data are reported from WasteDataFlow, an extensive database of information provided by local authorities. WasteDataFlow was developed under the guidance of the Chartered Institute of Waste Management and is maintained by Defra. Despite this comprehensive data on total municipal waste and recycling, recovery and disposal routes, information on resource and waste composition is still less than robust. For business waste, the most comprehensive published data available are the EA Commercial and Industrial (C&I) waste surveys carried out in 1999 and 2002. These data identify waste types by different industrial sectors for England and Wales; some data are available at the regional level but with no further resolution to local areas. However there is some uncertainty, particularly with regard to the 2002 data, as to the robustness of these data when viewing sectors at disaggregated levels, both geographically and for different business and waste types. The Waste Data Update 2006⁵, which is based on

operator site returns, has recently been published by the Environment Agency. This update, however, provides limited C&I waste data in disaggregated form. Furthermore, provision of information on origin, fate and destination of waste was not a mandatory requirement in its collection and so these data are often incomplete. Provision of this information is, however, stated to be improving.

For food waste from households the Waste strategy (2007) states that the waste stream accounts for up to 20% of household waste¹ and according to the recently launched, high profile WRAP campaign 'Love Food Hate Waste' one third of the food that households buy ends up as waste (see appendices 1 for more details). This figure was calculated from the amount of food purchased in the UK minus an estimate of UK food thrown away, from data on household waste collected and food waste home composted, fed to animals or disposed of in other ways⁶.

Food waste from commercial and industrial sources in the UK were estimated by the EA to be 6.2 million tonnes in 2002 or 9% of total waste². However a recent C&I waste composition study by the Environment Agency Wales based on physical analysis of waste sent for landfill concluded that around 13% of waste was food waste⁷. Clearly the robustness and detail of current datasets is limited.

3. Research approach and methodologies

In this section the different methodologies for estimating household food waste and business food waste arisings are explained. Household food waste is approached from two angles; firstly it is estimated from food expenditure data and secondly it is calculated from household waste collection data. The methodologies used to estimate business food waste use different survey data: the first applies published EA national data to the business profile of the Hospitality

sector, and the second makes use of data from a survey method developed by Thomas et al. (2006)⁸. For the case study in the paper each methodology is applied to Hampshire (including the County Council area and the Unitary Authorities of Portsmouth and Southampton). All approaches and methods were applied for 2004.

3.1 Mapping household food waste

Expenditure data approach (University of Surrey):

The starting point for this approach to calculating food waste from households was to estimate the expenditure on food by households within the case study area. From this the mass of food purchased was estimated using price data. This methodology is known as Local Area Resource Analysis (LARA) which is also the subject of Alexander et al (2008) in this issue⁹.

LARA estimates mean household expenditure by households in small local areas based on two data sets:

- The UK Expenditure and Food Survey 2004-05.¹⁰
- 2001 Census data.¹¹

Both datasets contain data on socio-economic and demographic characteristics, and these common variables enable the datasets to be linked. Specifically, the Census gives socio-economic and demographic characteristics of households in small geographical areas of the UK, known as Output Areas. Output Areas are small areas of approximately 124 households on average, that are as socially homogenous as possible, based on tenure of household and dwelling type. Mean weekly household expenditure on specific products in each Output Area is estimated from the Expenditure and Food Survey using a process in which selected socio-economic and demographic characteristics are matched between datasets. A LARA system diagram is given in figure 1. For further details of the methodology the reader is referred to Druckman et al (2008)¹² and Druckman and Jackson (2007)¹³.

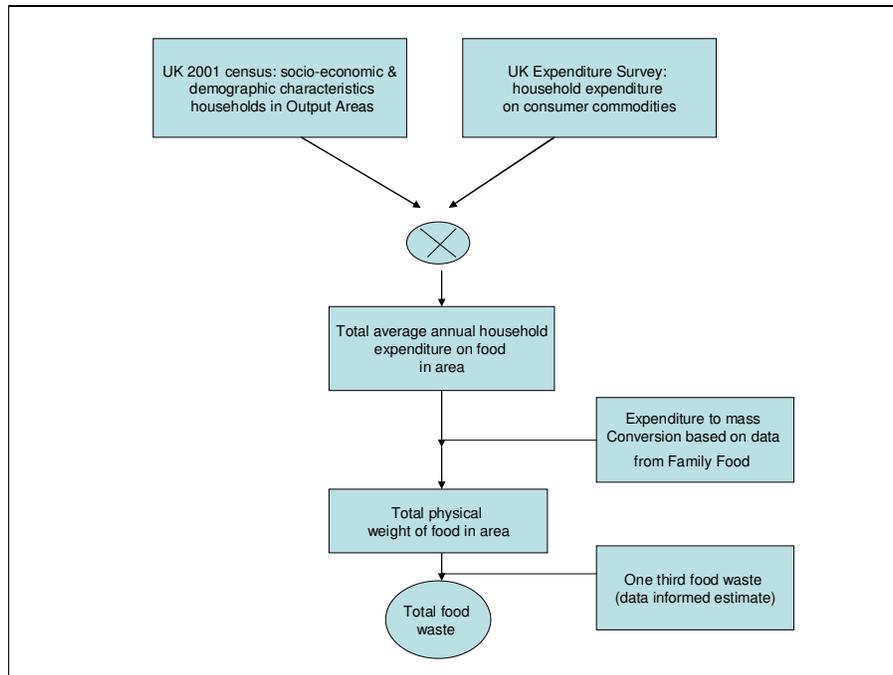


Figure 1: A system diagram of LARA as applied to food waste in this study

LARA is applicable to all Output Areas in the UK. The geographical case study area for this study has been defined according to postcodes, and therefore the Output Areas covered in the study were found by matching Output Area codes with the relevant postcodes^a. Data on the number of households in each postcode area¹⁴ were used to estimate total annual household expenditure on food in the case study area. This was converted into physical amounts of food purchased using data from Family Food, which is part of the Expenditure and Food Survey.¹⁰ Family Food provides information on the price of food products and the physical quantity of food provided at those prices. This information allows estimation of the physical amount of food resulting from a given level of expenditure on a specific product, for a given time frame.

The results from LARA thus give estimates of the flow of food materials coming into households in the case study area and the final step required for this part of the study was to estimate the amount of this food disposed of by households. Liquids such as milk were not

included in the flow of materials, as they were thought to be mainly disposed of via the sink. According to WRAP¹⁵, UK households throw away as much as one third of all the food they buy. For this reason the total weight of food purchased was multiplied by one third to derive estimates of household food waste.

The assumption that households dispose of a third of food they buy is a very broad average and takes no account of different rates of disposal between different areas socio-economic groups, or of differences between the disposal rates for individual food product groups. The assumption does account for the amount of food waste that is home composted or fed to pets but again this may vary between different locations and socio economic groups.

The general assumptions and limitations in LARA are covered elsewhere, as are validations of results estimated using the model (see Druckman et al (2008)¹² and Druckman and Jackson (2007)¹³). Of particular relevance to this study is the assumption in LARA that figures on expenditure by specific socio-economic groups of the UK taken from the Family Expenditure Survey are representative of the same socio-economic groups within a specific geographical area of the UK. This assumption ignores the effect that local food tastes, culture and regional prices may have on a region's food expenditure. Furthermore, in LARA it is assumed that weekly expenditure estimates from the Family Expenditure Survey, which are derived from expenditure diaries kept by members of each household for a two week period, accurately reflect annual expenditure on food¹⁶. Although diaries from the households in the sample are collected at different times spread throughout the year in order to compensate for seasonality, the possibility that the effects of seasonality are not fully captured in the survey must not be ruled out. The current study does not include expenditure on foods such as restaurant meals and fast foods, though expenditure categories for these items do exist, estimating household waste from these categories could result in double counting of Hospitality sector waste. Due to this

leftovers that are from (for example) restaurants, taken home and later disposed of at home are excluded from this study.

Household waste collection data approach (Open University and University of Southampton):

This approach estimated household food waste from household waste collection data for Hampshire and waste composition estimates. Collection data are taken from the Defra waste statistics for 2004/05 which records the total household waste for Hampshire (including the Unitary Authorities of Southampton and Portsmouth) as 895,000 tonnes.

Recent compositional data are not available for Hampshire specifically, so to calculate the amount of food waste (sometimes referred to as kitchen waste) in household waste in Hampshire national average composition data was used. The most commonly used estimates for national average composition of household waste are from Parfitt, 2002¹⁷; Defra, 2007¹; Hogg et al., 2007¹⁸ and Leach, 2007⁶; and they estimate food waste to be between 17 and 19% of total household waste. This approach used an average value of 18% for calculating the amount of food waste in household waste. This figure is for household waste that is collected for recycling or disposal and does not include any food waste which may be home composted or fed to pets. Using this national average data assumes that household waste composition does not vary geographically which is unlikely to be the case.

3.2 Mapping business food waste

Environment Agency 2002 survey approach (University of Surrey):

The approach to estimating the food waste arisings of the Hospitality sector in Hampshire was mainly based on two data sets:

- The EA Commercial and Industrial Waste Production Survey (2002)²; and
- Office for National Statistics (ONS) Employee data for the UK and Hampshire¹⁹.

A link between the two data sets was derived through a common reference to employees: ONS business data that identifies the number of employees in the sector was linked with national estimates of waste per employee for the sector. A system diagram is given in figure 2.

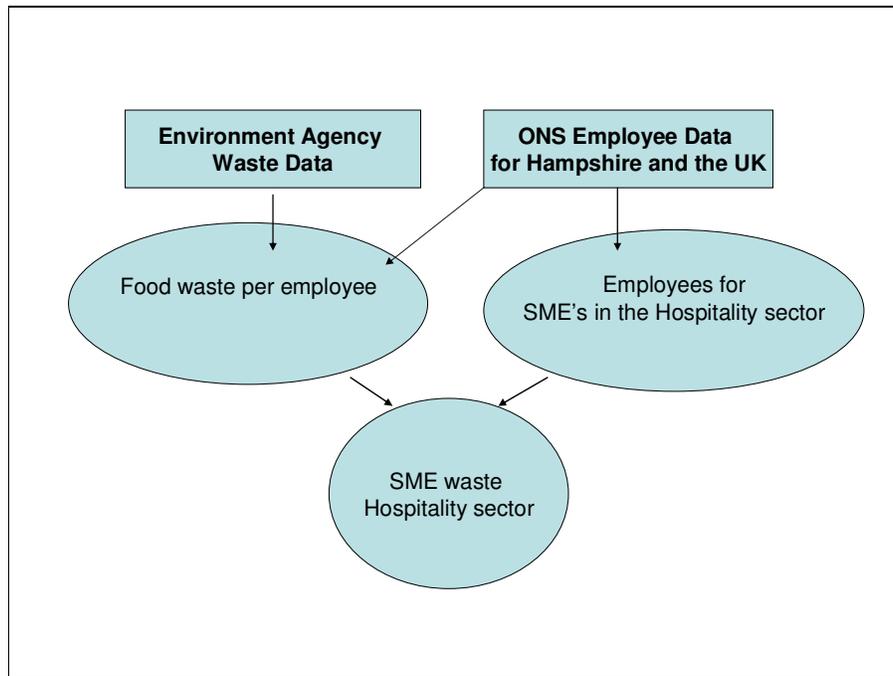


Figure 2: System diagram of how food waste was estimated for Environment Agency 2002 survey approach.

The first step in this methodology was to estimate the waste per employee in 2004. The available waste data are for 2002. From these data an estimate of the tonnes of waste per one million pounds of monetary output was generated in 2004 prices. This was then multiplied by monetary output in 2004 (2004 prices) to estimate tonnes of waste in 2004. This part of the method made use of monetary output data from the ONS.²⁰

An estimate of waste per employee for the UK in 2004 was then generated by dividing the total waste of the UK Hospitality sector in 2004 by the total number of employees in the Hospitality sector in the UK 2004 (UK waste estimates were developed from waste data for England). This produced an average waste per employee estimate for the Hospitality sector. Ideally waste per employee estimates would have been developed for different size bands of businesses based on the number of employees per business. This however, was not possible as data on the waste for different size bands of the Hospitality sector were not publicly available.

To generate an estimate of food waste (and total waste) for small & medium enterprises (SMEs) in the Hospitality sector in Hampshire 2004, the waste per employee figures for the UK in 2004 were multiplied by the total number of employees in SMEs of the sector for Hampshire in 2004. In doing so it had to be assumed that there is no difference in waste per employee for a region and nationally.

Mapping using the WasteQuest survey approach (Open University and University of Southampton):

The approach chosen for this survey was based on a detailed interactive questionnaire called WasteQuest which facilitates interrogation of a series of embedded databases. By focusing on questions about (i) waste containers used and frequencies of collection, and (ii) on the material types disposed of or recycled in each waste container, the approach builds a picture of the wastes from each business.

It uses simple questions which are tiered to seek information regarding each company's activities and the waste it produces. To achieve this, the smart questionnaire was constructed using an expert-system approach with both rule-based and hierarchical programming. It adapts the questions asked according to the user's responses, thus avoiding irrelevant and confusing

information. A further key feature of the smart questionnaire is its ability to limit the questions asked to those relevant to the company being audited, thus saving time and avoiding 'customer annoyance', whilst ensuring the data collected are the same in scope to enable full comparability in the analysis. Problems such as the units in which waste is quantified are overcome by using internal conversion factors, thus allowing the respondent to specify quantities in terms with which he/she is familiar.

The WasteQuest questionnaire was tested through an audit of C&I waste from SMEs in the food and food-related business sector in 2004 for Hampshire. This covered Food & Drink Manufacturing, Food & Drink Wholesale and Retail, and the Hospitality sector. The Hospitality sector includes: hotels, guest houses & campsites, restaurants, cafes & takeaways, pubs, clubs & bars, canteens & caterers. The purpose of the audit was twofold; to provide rigorous data on the resource potential of this waste stream in Hampshire and as a tool for businesses in maximising this potential by providing feedback on their waste streams and opportunities for increasing recovery. The survey carried out 170 face-to-face interviews with SMEs across Hampshire and across these sectors, with almost 50% of these in the Hospitality sector. Emphasis was placed on the micro and small businesses as these are the businesses where least information is available.

Estimates of the resource potential of wastes from the Hospitality sector for Hampshire were extrapolated from the survey results in relation to the business profile for the county. The approach taken was to use mean waste per employee data together with the total number of employees in SMEs in the Hospitality sector for Hampshire in 2004 from ONS data. A system diagram is shown in figure 3.

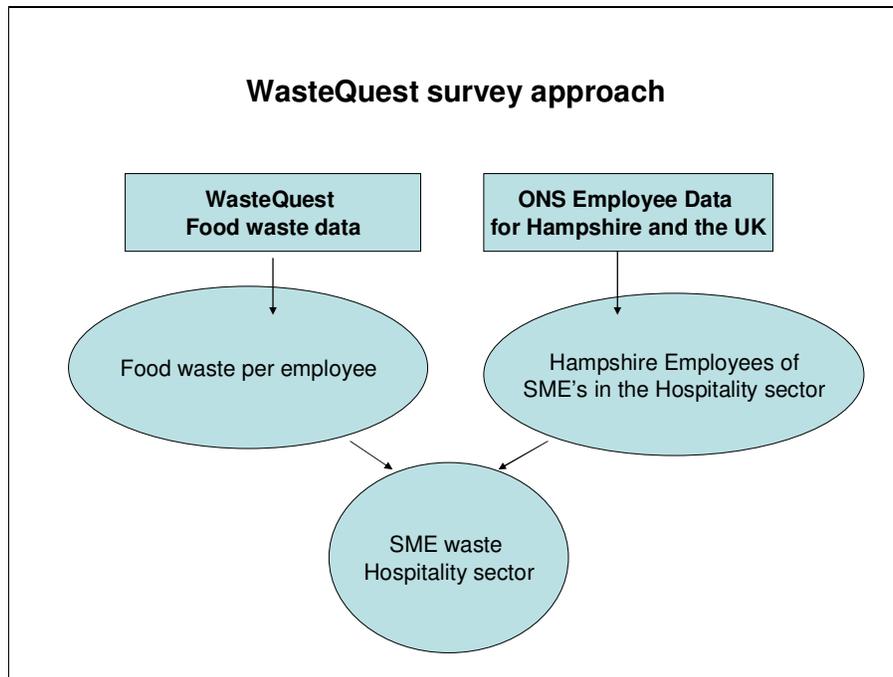


Figure 3: System diagram of the WasteQuest approach.

Statistical analysis of the survey is based on the assumption that waste per employee data could be aggregated across the three size bands of micro (0-9 employees), small (10-49 employees) and medium (50-249 employees) businesses. This assumption is supported by the reasonably strong positive correlation that was shown in the survey data between business sizes and waste per business, demonstrating that waste per employees was not dependent on the size of the business for these specific size bands (though it may be for other larger size bands). It should be noted that because the sample size for the WasteQuest survey was very small (though thought to be representative) the EA data has greater calculated relative precision at the 90% confidence level.

4. Results and data comparisons

In this section the results from the four different methods of estimating household and business food waste will be presented and compared, starting with the two methods of estimating

household waste, followed by the two methods estimating business food waste. The methodologies are applied to the case study area of Hampshire. The area is shown in Figure 4.

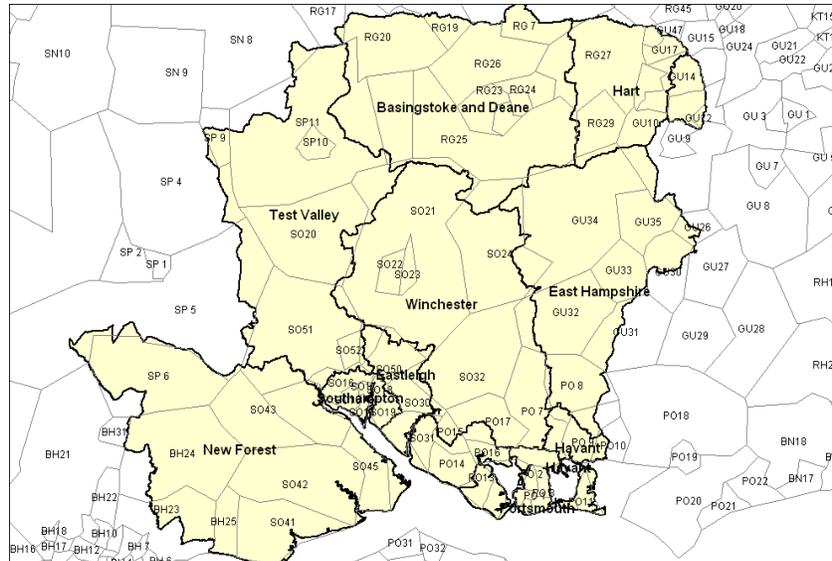


Figure 4: Hampshire County, showing postcode areas

4.1 Results from mapping household food waste:

This sub section identifies the results of the two different methodologies for calculating household food waste arisings within the case study area. The estimated food waste for Hampshire using the expenditure data approach was 192,000 tonnes in 2004, based on an estimate for food bought in Hampshire by weight with application of the assumption that a third of total food bought goes to waste.

Using the household waste collection data approach it was calculated that the amount of food waste generated by households in Hampshire in 2004 is 155,000 tonnes.

The household waste collection data approach applied the assumption (from national data) that 18% of total household collected waste is food waste. The food waste estimate from this

method is the best available from current data, but as previously suggested national average data may not accurately reflect the composition of Hampshire household waste.

4.2 Results from mapping business food waste

This section describes and compares the estimated amounts of food waste generated by businesses in the Hospitality sector for Hampshire, produced by two methods using two different sets of survey data as outlined in section 2.2. The sector was well represented in the SME questionnaire survey approach.

The Environment Agency 2002 survey approach generated an estimated figure of 4,200 tonnes of food waste for SMEs (small and medium sized enterprises with less than 250 employees) in the Hospitality sector in Hampshire. Results from the WasteQuest survey approach estimated the total food waste arisings for Hospitality SMEs for Hampshire to be 40,700 tonnes per year. Clearly there is a huge disparity between the two approaches.

Table 1 summarises the estimates of total waste and food waste for the Hospitality sector in Hampshire from the WasteQuest survey & Environment Agency 2002 survey approaches. The results identify that the WasteQuest survey approach generates total waste estimates over double (225,000 tonnes as opposed to 92,000 tonnes) the amount of the Environment Agency 2002 survey approach. Food waste as a percentage of total waste was much higher in the WasteQuest survey approach than for the estimated amount for the EA 2002 survey (18.1% as opposed to 4.6%). The combined effect of these differences results in the estimate of food waste by the WasteQuest survey approach being roughly ten times that from the Environment Agency 2002 survey approach.

Approach	Total estimated food waste from Hospitality sector, Hampshire (tonnes)	Total estimated waste from Hospitality sector Hampshire (Tonnes)	Food waste as a percentage of total waste
EA 2002 survey approach	4200	92000	4.6
WasteQuest survey approach	40700	225000	18.1

Table 1: Total waste and food waste of Hampshire for the WasteQuest survey approach & Environment Agency 2002 survey approach

To attempt to corroborate and clarify these findings, comparison can be made between the average total weight of waste (all waste, not just food) per business recorded by the WasteQuest survey and data from the EA 1999 survey for a limited range of micro and small Hospitality business types for which equivalent data were available (ideally 2002 estimates would have been used but robust estimates were not available)²¹. These data are shown in Table 2 and indicate that the WasteQuest findings are consistently higher than the EA 1999 data and also that the data in both surveys have a very high level of variability associated with them.

Waste survey approach	Business size bands			
	Micro		Small	
	Mean waste/business (tonnes/annum)	Standard deviation	Mean waste/business (tonnes/annum)	Standard deviation
EA 1999 survey data				
Hotels	16	13	78	96
Restaurants	17	22	80	98
Bars	15	16	79	78
WasteQuest survey data				
Hotels	22	12	153	92
Restaurants	22	10	186	87
Bars	27	13	95	39

note 1: for this analysis micro businesses included were those with 2-9 employees; small business those with 10-49 employees.
 note 2: EA 1999 data from a bespoke analysis of the survey database carried out by J Ellis (2005)

Table 2: Comparison of average total waste per business from the Environment Agency 1999 survey and the WasteQuest survey data

Additionally the use of average food waste per employee figures for all size bands (and not waste per employee figures specific to SME's) in the Environment Agency 2002 survey approach, was found to lead to underestimation of the waste figures (via inspection of unpublished data). On this basis it is apparent that at least two different factors seem to lead to the difference in total waste between the two approaches, identified in table 1.

Some important information relating to actual reporting within the surveys themselves can help in identifying why the estimate of food waste is high in the WasteQuest survey approach and a lot lower in the Environment Agency 2002 survey approach. Importantly in the WasteQuest survey only 6% of the waste stream was recorded as unclassified, compared with the EA 2002 survey where general or mixed waste was the largest overall of the 8 compositional categories recorded, accounting for 32% of industrial waste, and 51% of commercial².

5. Discussion

A key issue arising from the research project and the exploration of waste data is the importance of clear consistent & robust data on waste composition and arisings to underpin our understanding of resource flows not only on a national but also at a more local level.

5.1 Discussion of approaches to estimating household food waste

The expenditure data approach estimates the amounts of food waste generated by households in Hampshire to be 24% higher than when using the household waste collection data approach. The approaches differed in whether they attempted to account for food waste that is home composted, fed to pets or not identified but classified as general household waste, and how they incorporate locally specific factors. The household waste collection data approach uses local household waste data but in the absence of local waste composition data needed to rely on

national average data on food waste as a percentage of total household waste. The expenditure data approach modelled local variations in food purchased (and consequent physical flows) but relied on a national data assumption about the proportion of food bought that is wasted. In both cases the use of national average data might result in inaccuracies and both approaches would benefit from more specific local data.

The assumptions used in each approach have the ability to generate significant differences in results. Specifically in the expenditure data approach the key assumption is that one third of the food bought becomes food waste. In the household waste collection data approach the key assumption is that 18 percent of total collected waste is food waste. These key assumptions can be questioned and investigated.

The highly publicised WRAP ‘one third of food is wasted’ statistic comes from their estimate that the amount of food waste thrown away by households in the UK each year is 6.7 million tonnes¹⁵. This amount is equivalent to 22% of the total amount of collected UK household waste. If this 22% figure for food waste as a proportion of total household waste were applied to the household waste collection data approach for Hampshire it would suggest that 194,000 tonnes of food waste were produced in Hampshire. This is almost the same amount as the 192,000 tonnes predicted by the expenditure data approach for Hampshire.

Therefore it can be seen that the main difference between results obtained by the two approaches can be explained by the estimates of proportions of food that households waste (or the proportion of food waste of total collected waste for the household waste collection data approach) and the inclusion of food waste home composted, fed to pets in the expenditure data approach, not accounted for in the household waste collection data approach. This again emphasises the need for better waste composition data.

If the amount of food waste is assumed to be 18% of total collected waste as in the household waste collection data approach then to generate the same tonnage of waste via the expenditure data approach would require an assumption that 27% of all food brought goes to waste, rather than one third. A recent Rural Economy and Land Use (RELU) programme funded project, *Milà i Canals* (2007)²² reports that the amount of food not eaten (and hence waste) in households is not very well known, as it is highly variable depending on the food product. Carlsson-Kanyama et al. (2001)²³ suggests that 16% of potatoes bought are lost, while Carlsson-Kanyama and Faist (2000)²⁴ give figures of 18% for cabbage, and 28% for carrots. *Milà i Canals* (2007) assumes that for all fresh vegetables, 20% of the food input to the household leaves it as solid waste. Estimates are lower than the WRAP estimate of one third food waste of total food brought. A later published (after initial work conducted in this paper) & comprehensive publication by WRAP 2008, identifies the percentage waste (of total physical weight of food brought) for a wide variety of food products, the percentages vary widely depending on the types of products.²⁵

In reality to apply one percentage waste figure across all food categories is a fairly crude method to estimate food waste from expenditure data. Different food products may have different rates of disposal for a variety of reasons, as identified by WRAP (2008). If expenditures vary significantly regionally (e.g. due to socio – economic background) for different food categories so that food expenditure for the region or local area is not spread across food expenditure categories in the same proportion as nationally, then the (national) percentage waste figure e.g. one third food waste assumption may not hold. For example if potatoes have proportionally higher expenditure regionally than nationally, this does not necessarily mean that waste will have increased in a linear fashion, as different products have different disposal rates. Some discrepancy between results could occur therefore due to the way in which regional and socio-

demographic factors were taken into account. The expenditure data approach modelled food purchased at a local level and was able to take into account the socio-economic background of households in the area. Given that the socio-economic profile in the South East is different to the national average (with generally higher expenditures) then using the national average figure of one third wasted may give a higher than national average result for food wasted. The recent WRAP (2008) publication was used to inform this issue. The one third waste assumption was substituted with estimated waste percentages (waste as a percentage of weight of food brought) for ten broad product categories. The expenditure data approach using these new percentage waste figures produced an estimate of 171,000 tonnes of household food waste for Hampshire. This figure is closer to the household waste collection data approach, but still higher.

5.2 Discussion of approaches to estimating business food waste

Focus now shifts to the food waste generated by business. The results from the two approaches to estimating business wastes for the Hospitality sector in Hampshire presented a less direct comparison (than the household waste comparison) with one estimate using published national and the other regional survey data. Comparing the results for SMEs in the Hospitality sector in Hampshire, the WasteQuest survey data approach estimates food waste arisings that are around ten times greater than those estimated by the Environment Agency 2002 survey data approach, 40,700 as compared with 4,200 tonnes. Estimates of total waste for this sector are over double the amount of the Environment Agency 2002 survey approach, 225,000 as compared with 92,000 tonnes.

In general there are a number of factors that could have brought about differences in the food waste estimates from the two survey approaches. The WasteQuest survey data is based on a smaller sample size than that used in the EA survey data and this reduces confidence in the

average values obtained and could have led to inflated estimates. Regionality of WasteQuest data, and the fact that it used waste per employee figures specific to SMEs (not an average waste per employee figure for all size bands as in the EA 2002 survey data approach) could also have led to higher estimates in the WasteQuest survey approach. This was confirmed to have an effect in 1999 waste data for the hospitality sector. Also the survey methodologies used to derive the two data sets were very different and the WasteQuest survey may have recorded waste streams not identified by businesses in the EA survey. The WasteQuest survey placed an emphasis in the questionnaire on capturing all waste and recyclable material including that disposed of, reused or recycled in ways other than through the main waste collection routes. Some of this material may not have been explicitly captured in what the businesses classed as waste in the EA survey.

From results it is clear that the different survey techniques did substantially affect the respondents' waste estimates. General or mixed waste was the largest of the 8 compositional categories recorded in the Environment Agency survey, accounting for 32% of industrial waste, and 51% of commercial waste. In the WasteQuest survey only 6% of the waste stream was recorded as unclassified or miscellaneous. It is likely that this difference plays a significant role in the WasteQuest survey approach estimating food waste at much higher levels than the Environment Agency 2002 survey approach. It should be stated that although this is apparent, the Environment Agency surveys did ask respondents what percentage of general or mixed waste was food waste, however no information is provided on this in the Defra published tables of wastes by sector and only a very limited amount of this data is available online on the waste exchange material calculator.²⁶

The WasteQuest survey approach estimates *total* waste for Hospitality SMEs in Hampshire at around 2.5 times that of the Environment Agency 2002 survey approach, in part due to different

survey techniques used and in part due to the use of average food waste per employee figures. The WasteQuest survey approach calculates food waste as 18% of total waste compared to the Environment Agency 2002 survey approach at just over a quarter of this. The combined effect compounds these differences resulting in a food waste estimate for the WasteQuest survey approach of almost ten times that estimated by the Environment Agency 2002 survey approach. Unpublished data later received from the Environment Agency confirmed very similar findings in the 1999 C&I waste data. The unpublished 1999 data however, showed that when food waste present in mixed waste is included in addition to waste per employee figures specific to SME's, the Environment Agency 2002 approach produces similar figures of food waste to that of the WasteQuest survey approach. The more detailed data were also able to further confirm that the omission of food waste present in mixed waste is by far the most dominant factor leading to underestimation of food waste.²⁷

Though it is difficult to identify all the precise reasons for the differences in estimates from the WasteQuest survey approach and Environment Agency 2002 survey approaches, it is clear that the amount of food waste classified as general or mixed waste in the Defra published Environment Agency data accounts for the vast majority of the difference in the food waste estimates of the Hospitality sector. This finding indicates that the robustness of estimates of individual waste streams (such as food waste) of the Hospitality sector for the Defra published EA 2002 survey data is limited, due to such large amounts of waste being put in general or mixed waste categories. There is potential that this finding could apply to other sectors such as the Retail sector.

The general findings of the paper suggest that for government and non-government, business and policy makers attempts to make the most effective and efficient plans for new waste management infrastructure will be difficult and hampered by a lack of current, reliable, robust

published data on which to make their decisions. This issue is illustrated by the fact that the Waste Strategy 2007, states that the food sector constitutes two thirds of total C&I food waste. This figure is based on Defra published 2002 C&I food waste figures² (and does not include food waste within mixed waste) and is therefore incorrect.

6. Conclusions and Recommendations

In this paper we identify the differences that occur between different methods of estimating food waste for the same households and hospitality businesses within a specific geographic area (Hampshire in the UK).

Comparison of the household waste collection data approach with the expenditure data approach highlights a potential range of estimates for household food waste within Hampshire. Much of the 24% difference in the estimates is due to the assumptions used by the two approaches about how much food is wasted by households. The expenditure data approach relies on an assumption of the percentage of food purchased that is wasted, whereas the household waste collection data approach relies on an assumption about the percentage of total collected household waste that is food waste.

To improve the estimates using the household waste collection approach needs better local area or regional data on the percentage of collected household waste that is food waste. For the expenditure data approach, data to inform the percentage waste (of food brought) assumption has been substantially improved by the very recent WRAP (2008) publication. Data identifying the amount of food waste for each food product amongst different social economic groups would also improve the expenditure data approach, the WRAP (2008) publication provides

some data that could potentially be used. Future studies of household food waste should make use of this new published data.

A key benefit of the expenditure data approach is that it has the capacity to be able to take account of socio-economic and demographic characteristics of an area which affects expenditure on food as well as waste but without having to generate local area and region specific waste profiles. The approach can be applied consistently across the whole of the UK.

The two approaches to estimating business food waste for the Hospitality sector gave estimates that showed a marked difference between them. A key finding was that the Environment Agency 2002, Defra published C&I food waste data is very likely to be underestimating food waste for the Hospitality sector, and potentially by quite large amounts due to the amount of waste that was classed as general or mixed waste and which potentially contained food waste. It should also be stated that the WasteQuest survey approach, due to the small sample sizes, possibly over estimates food waste for the Hospitality sector. A more positive finding is that when food waste within mixed waste category (from the more disaggregated unpublished figures) is included, the two different approaches estimate similar amounts of food waste.

The findings illustrate that gaps in knowledge and uncertainties within current published food waste data (and indeed potentially other waste streams) are substantial, especially with regard to C&I waste. At the same time pressures are mounting to divert waste from landfill, particularly biodegradable waste. These pressures are highly likely to result in an expansion in waste infrastructure, and treatment facilities that divert waste from landfill. This expansion will require significant investment by local government, business, regional development agencies

and others. The lack of robust, reliable and disaggregated published waste data will substantially limit the ability of waste management decision-makers in planning investment in the most effective and efficient ways. It will also limit the potential to reduce waste with minimum environmental impact as understandings on location and weight of waste produced in an area cannot be accurately identified with current published data (for example, this could result in emissions being generated from transportation of waste to inappropriately positioned waste management infrastructures). It is clear that the situation could be significantly improved by publication of more of the current UK C&I waste data that is available. In the near future however, operator site returns may provide more detailed and robust C&I waste data. Beyond this, surveys such as WasteQuest, designed to accurately identify individual waste streams, can be resource intensive, but if they have a better capability in identifying individual waste streams from specific business sectors then the surveys may be justified. A series of national sector specific surveys to identify waste composition through a collaboration of industry (or trade associations), government and academics could maximise available resources to enable better data to become available. If more comprehensive, high quality national waste data sets were to become available such as WRAP (2008) for household food waste, more pragmatic approaches such as the household expenditure approach and a similar pragmatic approach for business waste could enable region specific (or more detailed geographic) estimates of waste to be obtained, with limited resource requirements. This would increase the possibility of planning more efficient and effective positioning of waste management infrastructure with minimal environmental impact.

Acknowledgements

We would like to thank Charles Banks, Paul Dacombe, Angela Maycox and Talat Khan of the University of Southampton for their contributions to the Southampton University/Open University joint research project. We are grateful for funding from EPSRC Sustainable Urban Environment Waste Consortium programme (Grant Number GR/S79626/01) and from the Veolia Environmental Trust for Landfill Tax Credit Scheme funding. Thanks also to Hampshire County Council, the South East England Development Agency and the Environment Agency for their help and support. Data from the 2001 Census are provided by the Commissioned Output Census Service of the Office for National Statistics (Crown Copyright 2005).

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Appendices 1:

WRAP commissioned research shows that just over 19% of UK municipal waste, which includes household waste, is food waste. This percentage was applied to official statistics on household waste collection from Defra, to calculate that in 2005/6 UK local authorities collected 5.9 million tonnes of food from households as part of their mixed ('residual') waste and recycling/composting collections. In addition, it was estimated that approximately 800,000 tonnes of food waste is dealt with through home composting, feeding to pets and wild animals etc. The total of this waste was then estimated as a percentage of total UK food purchased.

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