UN environment programme

FOOD WASTE INDEX REPORT 2021

APPENDIX

2 Appendix: Methodology for level 1

A summary of the methodology used for Level 1 estimates is presented in Section 2.2 of the Food Waste Index (FWI) report. This appendix covers the details of this methodology, in particular:

- How existing food waste studies and estimates were identified and obtained (2.1)
- How the data found from these studies was evaluated to inform its inclusion and our level of confidence in the estimate (2.2, 2.2.3, 2.2.4)
- Transformations and adjustments applied to data to increase comparability (2.2.2)
- The methods of calculation used to extrapolate data and create relevant estimates (2.3)
- Methods considered for extrapolation but rejected in favour of the one used (2.4)

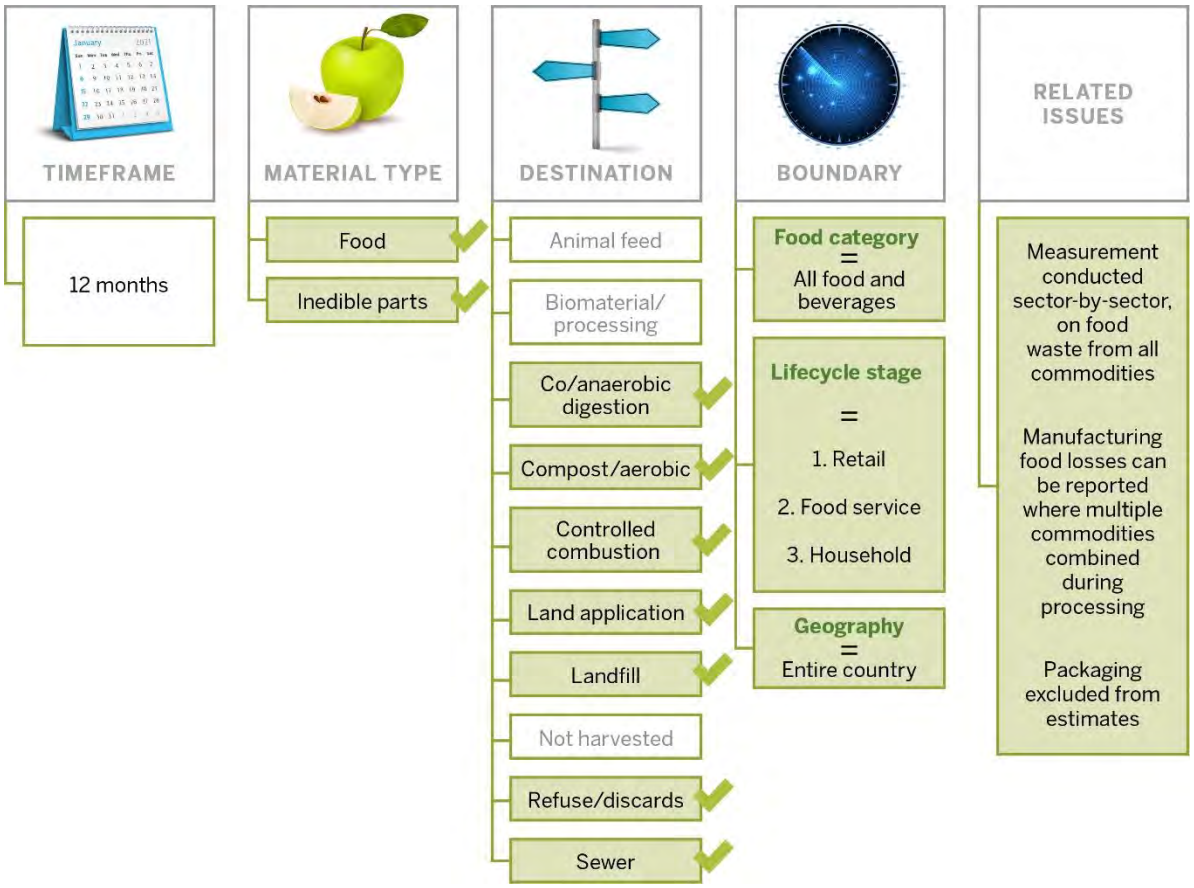
2.1 Literature Review

This section describes the process of finding relevant studies for this project. The section is split into two: the first part describes the characteristics of the studies being sought, the second part describes the methods used for searching, including the limitations.

2.1.1 Characteristics of studies for this project

This section describes the types of food-waste estimates that were sought as part of this study. In general, studies with comparable boundaries with the definitions of the Food Waste Index (FWI) were sought (although differences in definition were adjusted for where possible). In addition, the methodologies of studies included had to be of sufficient accuracy for tracking levels of food waste over time.

Figure 1: Definitions of food waste used for the Food Waste Index.



Timeframe: When searching, we generally looked for papers which were published **after 2005** in order to find data which had been gathered no longer than 15 years ago. Despite having a cut-off date of 15 years ago, most of the studies which were used came from the last five years. Many countries which had studies pre-2010 have refined, repeated or updated those studies and latest figures were used in the current research.

Table 1: Distribution of studies by publication year

Study publication date	Number of studies	Number of datapoints in studies
Before 2005	0	0
2005-2009	4	4
2010-2014	21	31
2015-2019	51	98
2020-	8	19
Total	84	152

Note that a single study can contain multiple datapoints (for different sectors, geographies or times). The publication year does not necessarily reflect the age of a datapoint referred in a study; many are published in recent years but refer to older datapoints.

Material type: consistent with the FWI methodology, we searched for studies that quantified total food waste: both edible parts (sometimes referred to as 'avoidable' or 'wasted food') and inedible parts (unavoidable food waste). Studies did not need to separate these two parts from one another.

However, where a study only included the edible parts, this was collated and – where possible – adjusted to account for the unquantified inedible parts (see Section 2.2.2.2).

Destinations: studies were sought that conformed to the destinations defined as food waste by the FWI: co/anaerobic digestion; compost / anaerobic digestion; land application; controlled combustion; sewer; litter / discards / refuse; or landfill. Studies were still collated if there were discrepancies between the destinations covered by the study and those covered by the FWI: where possible, adjustments were made (e.g., to remove food fed to animals from the estimate). This is discussed in Section 2.2.2.7.

Sectors: studies were sought covering any of the following: Household, Retail[1], and Food Service. In the case of Food Service, most studies reviewed did not make estimates for the entire sector. In general, we pursued papers which from the title and abstract covered a sufficiently large portion of the sector (i.e., restaurants, or canteens across a range of settings) but ignored those ones which had a very particular and narrow view (e.g., studies focused on university canteens only).

The definitions of sectors are outlined in Section 3.2.1 of the FWI report according to International Standard Industrial Classification of all Economic Activities (ISIC). There are occasional differences between individual studies and these definitions. We applied judgement as to when a study's sectoral definition deviated too much from that our aim, with such studies being excluded. In many cases, insufficient information on sectoral coverage was provided to make this assessment.

A large number of studies present waste data based not on its source but its destination, i.e., collection by Municipal Solid Waste (MSW) services and disposed of in landfills, incineration and other waste destinations. Such studies were only included in situations where the MSW had been disaggregated by waste source to a sector comparable to the sectors being used here. For a fuller description of the approach to MSW papers, see Section 2.2.4.1.

Geographic coverage: *Studies were considered for inclusion regardless of whether their waste estimate was formed at a national or subnational level. This meant that subnational studies such as scoping studies for municipal waste plans, which were not focused on food waste estimation but did disaggregate waste to that level of detail, were considered. As a result, we may have included a number of estimates which are otherwise overlooked in the food waste literature. Studies at this level were particularly relevant for the Household sector, which was often their focus. A distribution of datapoints by scope of study can be viewed in*

[1] Note: Wholesale is not covered by the Food Waste Index. Where estimates for retail have also included wholesale, efforts were made to remove the wholesale estimate, where it was specified in the study. In some cases, disaggregation was not possible, or it was unclear if wholesale was included in the study. These were not adjusted further.

Table 2. The majority of studies at a regional level provided by-country estimates, these were treated separately. Only one paper presented a multi-country sample in aggregated form, this was not included (Malefors et al., 2019).

Often, the subnational estimate provided a per capita waste generation figure rather than a total waste generation figure. As many subnational estimates were urban in nature, this per capita waste may not be considered representative for the entire country. As a result, the confidence in estimates from these studies is reduced. This is discussed in section 2.2.3.1.

Table 2: Number of datapoints, by sector and geographical scope of study

	Household	Food Service	Retail
Nationwide	38	24	27
Municipality & Sub-national region	53	8	2

Methods and approaches: in this project, we were looking for studies which involve direct measurement of food waste or use data from other studies that involved direct measurement. This criterion is important as the purpose of the FWI is to track levels of food waste over time. This purpose requires estimates to be reasonably accurate, collecting data from the relevant geographic area and time period and using a methodology without substantial bias (or a methodology where biases can be adjusted for).

Therefore, studies with the following methodologies were included: waste compositional analysis[2], direct weighing and scanning of wasted items. We also collated studies that involved diaries or collated information using surveys. For studies focusing on Household food waste that used diaries, adjustment was made to account for underestimation (see sections 2.2.2.3 and 2.2.2.4 for details), but our confidence in the resulting estimate was lower than other methods included (see section 2.2.3.2). For surveys, estimates for household food waste obtained directly from surveys (e.g., asking people to recall the amount of food waste generated) were not used. However, surveys of business representatives asking them to report their waste generation were included. These surveys, and data from industry more generally, were included due to the barrier to accessing commercial data. In very few studies presenting such data was it clear *how* it was generated, i.e., whether the businesses directly measured or estimated waste, and how robust measurements taken were. In the interest of ensuring there was sufficient data, a level of trust that self-reported business estimates were informed by measurement was therefore applied.

[2] Many authors use the term 'waste audit', especially when examining the waste of a restaurant or supermarket; all 'waste audits' have been coded as 'waste composition analysis' for simplicity.

Table 3 presents datapoints by methodology. For a discussion of method and its relation to confidence levels, see Section 2.2.3.

Table 3: Number of datapoints, by quantification method and sector

Method	Household	Food Service	Retail
Data from industry		2	6
Diaries	12		
Literature	13	10	11
Mixed method	5	7	3
Surveys, questionnaires and interviews		2	1
Waste Composition Analysis	58	8	6
Unclear, Governmental reporting	3	3	2

Shaded blanks refer to methods which are not appropriate for that sector, meaning no studies were found. The solid blank refers to a rejected methodology.

In the case of studies which combined waste generation factors with some other national statistic, the determining factor was the origin of these waste generation factors. In some cases, the waste generation factors were derived from direct observation in the relevant country (see for example, the USA (U.S. Environmental Protection Agency, 2020)); in others, it is derived from a modelled estimate, typically using the FAO 2011 estimates (Gustavsson et al., 2011), often from data that is old and / or from another country. The former would be accepted, and the latter would not for our purposes.

In a number of countries, there are existing publications which aggregate studies across multiple sectors for the purposes of estimating and reporting on food waste. In the last few years, a number of 'baseline' studies have been published for this purpose (see, for example, Australia (Arcadis, 2019), Germany (Schmidt et al., 2019) or the United States (U.S. Environmental Protection Agency, 2020)). These typically took the form of meta-analyses for the study scaled by country-specific factors. Where these studies were identified, they were taken as the authoritative source for the country and we did not prioritise further searches for those countries, nor the primary data sources on which the baseline was formed, unless some sectors were not covered by the publication. As a result, for some countries there are many more studies on food waste than presented in this database.

2.1.2 Search process

This review took a multi-pronged approach to sourcing data and estimates:

Existing review papers: As a starting point, certain literature reviews were used, notably the Xue et al. (2017) meta-analysis. This paper collated national estimates of food waste for multiple sectors, with extensive coverage of studies until approximately 2015, including meta-analyses published up

until that point. The database in the supplementary information of Xue et al. was analysed to understand the degree to which studies referenced conformed to the required characteristics, as set out in section 2.1.1. Studies that measured a specific foodstuff or commodity (e.g., wheat) were excluded from further consideration. In contrast, studies that measured 'Food & Drink', 'Food, Drink & Tobacco'; 'Food & Organic Waste'; 'Total Food' or 'Total' were retained for consideration. The Xue et al. database was also filtered by measurement method (to remove any calculations using proxy data) and sector to form a longlist of data that could potentially pass the current study's criteria. These papers were then accessed and read to obtain further methodological detail which would help in determining studies to accept or not.

Several of the studies in the Xue et al. (2017) spreadsheet were listed as 'Literature' papers, i.e. the food waste estimate was derived from a reference in the text. In these cases, the reference was followed where possible to the original source in order to determine its suitability. Where possible, the original source paper has been referenced directly in the current study.

In addition to the Xue et al. (2017) data, several other meta-analyses were used in the research process. This included:

- Relevant chapters on regional measurement in the *Routledge Handbook of Food Waste* (Reynolds et al., 2020) were read and bibliographies followed if the papers had not previously been identified.
- Several Europe-wide reviews of member-state estimates, notably BIO Intelligence Service (2010), Stenmarck et al. (2016) for the FUSIONS project and Caldeira et al. (2019). Based on the information in these documents, some studies referenced were obtained and read. For studies which were inaccessible to the authors, whether a study was included in the current research was decided on by the description of the method provided by the meta-analysis. For example, the Stenmarck et al. (2016) estimate includes judgements of data being a 'sufficient quality' with definitions of that quality benchmark. Similarly, Caldeira et al. (2019) offer in most cases a good level of methodological detail of the studies they reference. In these cases, the Method was listed as 'Literature'.
- WRAP's Food Waste Atlas was consulted. This is a repository for food waste data from a wide range of sources. Some of these sources – such as for specific private companies – were not relevant for our purposes. However, the data on international estimates and from academic papers was consulted to check for estimates not otherwise identified.
- Abiad and Meho's (2018) review on food loss and waste in the Arab world was consulted as a source of information from this region. The individual papers were then followed up and included based on their suitability.
- Two regional analyses by Hamid El Bilali (2018; 2020) for the Gulf Cooperation Council and North Africa was consulted, with any potentially suitable studies followed to the original source. However, most of these were speculative figures not derived from direct measurement. As the author points out for North Africa, there is "in the selected documents no comprehensive analysis of the extent of food wastage in distribution and consumption". Whilst some studies on food losses were identified, they were not relevant for our purposes.
- The bibliography of a recently released meta-analysis on directly measured food waste by Dou and Toth (2020) was kindly provided by the author while still in the review stage. Those studies in the bibliography which had not previously been identified were accessed and referenced where applicable.
- Van der Werf and Gilliland's (2017) review article of food waste in developed countries was consulted, with studies with the appropriate scope being read and referenced directly.

- The World Bank's 'What a Waste' dataset, which is associated with the report *What a Waste 2.0* (Silpa Kaza et al., 2018) was analysed. The information in this dataset contains the amount and composition of MSW for a wide range of countries and many cities around the world. Depending on the country, MSW may cover some or all the sectors relevant to the current study (Household; Food Service; Retail). In some studies referenced in the *What a Waste* dataset, information is disaggregated by sector, allowing it to be used in the current study (see 2.2.4.1). A second complicating factor was that many studies did not report food in the MSW streams separately from other organic material. To identify studies that were likely to contain food-specific data, the dataset was filtered to only include cities or countries where different data for different organic fractions was presented (specifically, garden waste being separately reported from 'organics / food'). These papers were searched for: several were personally communicated to the World Bank for the purposes of their report and were not public and some were not findable based on the information presented. Any relevant papers found through this dataset were accessed and added to our dataset directly as unique paper references.

Searches of academic databases: Additionally, direct searches were conducted online. These were conducted both using Google Scholar and the Sciences Po Bibliothèque, a dedicated social sciences library with access to over 20,000 electronic journals. Numerous searches were conducted using these engines, which combined search terms such as "food waste" and "quantification", "measurement", "national estimate", "wasted food" "food wastage" and "food loss". These were conducted both as time-limited searches after 2014 (to prioritise those papers not considered by Xue et al. (2017)) and on other occasions, after 2005. These searches were conducted during July-August 2020. Searches were conducted in English, with supplementary searches conducted in Arabic and French. Studies identified in other languages were considered where found using online tools Google Translate and DeepL to check for possible relevance.

The search terms present a huge number of results, many of which were not usable for our purposes. Papers which were specifically about the potential valorisation of food waste and its *chemical* composition were ignored, unless the title alluded to the collection of waste from a specific geographic area. Similarly, a large number of papers were returned which focus on the demographic and behavioural determinants of (self-reported) food waste, or food waste-related behaviours, alongside a large number of papers documenting interventions in specific sectors to reduce food waste. These papers are important for designing policy to reduce food waste and deliver SDG 12.3. They were not, however, relevant for our purposes and so were filtered out.

During the review, papers were sought that mentioned a specific geographic area (whether national or subnational, e.g., a city or a state), direct measurement of food waste, and specific sectors (Household, Food Service, Retail). If the title, excerpt and/or abstract mentioned some or all of these elements, it was downloaded and reviewed in more detail. In many cases, the paper reviewed at this stage did not have an original estimate of food waste but referenced estimates from other papers, which were then tracked down if perceived relevant. This led to a 'snowball' search from the studies found through the online searches.

It should be noted that due to generic search strings such as "food waste" + "quantification" turning up as many as 17,000 results on Google Scholar, it was not possible to review every page of search results for every search conducted. After a few hundred results the search results tended to become less relevant (e.g., focusing on chemical composition, anaerobic digestion or consumer attitudes). Once this point was reached, no further citations were reviewed, and a new search was typically started. Searches conducted using Sciences Po Bibliothèque were more precise and every page of

the search was therefore evaluated. Whilst it is a limitation that searches could not be pursued in full, it was assumed that by reading the identified papers and following the references to other estimates, those we did not find directly would be found through the bibliographies of other papers.

In September 2020, after the initial period of review, codifying and building the database, some country-specific searches were conducted. These were to focus on two regions where no possibly usable estimates had been identified: Northern Africa and Central Asia. Using Google Scholar and the main Google search (to possibly include results from NGOs, local associations or government) searches for [country name] + "food waste" OR "wasted food" OR "food wastage" were carried out for each country in the regions. None of these searches returned usable estimates.

It should be noted that three other regions have no datapoints in them: Melanesia, Micronesia and Polynesia. Region-specific, rather than country-specific, searches were carried out and two notable sources were found: a 2020 paper by Joseph and Prasad (2020) and a 2016 regional strategy document (SPREP, 2016). The former provides waste compositional analysis information of MSW, the latter an estimate of household generation but only providing an organic rather than food-specific share. Whilst some combination of these two sources could provide a rough estimate of household food waste generation, at least to identify the order of magnitude, MSW studies and household studies reporting organic waste only were not used in the current study (see Section 2.2.4).

Waste-specific databases: As well as searches of academic databases, some data sources were provided through personal contacts of the team which helped identify other sources of information.

One contact highlighted the JICA (Japanese International Cooperation Agency) database. Based on the JICA studies already consulted by that point, "waste management" was searched across the last ten years of publications on the database. This provided a fruitful avenue and several JICA studies have been included. Whilst these studies were primarily designed as scoping to understand the scale of waste problems more generally in a city or country, the inclusion of food-specific measurement (rather than simply 'organics') in detailed, Household-level waste compositional analyses provided usable data. Unfortunately, often the Retail and Food Service figures were either grouped in ways we could not disaggregate (i.e., supermarkets and restaurants considered together) or were not scaled beyond the waste per establishment, limiting their viability in producing an estimate for the city or country in question without additional, unavailable data. This data gap is discussed more in Boxes 2 and 4 of the main FWI report.

Based on the experience with the JICA database, it could be possible that other international development organisations have databases with waste estimating studies. There is some evidence to suggest that JICA are particularly unique: JICA papers were regularly referenced in the academic literature, alongside which there was a notable absence of studies from comparable organisations. Similarly, a UN Habitat study in Nairobi, Kenya (Takeuchi, 2019) based itself off a JICA study in the same area (JICA, 2010) and replicated its methodology, implying that JICA presents a body of expertise on this issue. It may still be possible that other development organisations present 'untapped goldmines' and this being signposted to the authors would help ensure in future updates and revisions that these estimates are included.

Reaching out to the research community: Another use of contacts involved posting in a Google Group for researchers on food waste[3] explaining the nature of the review, the boundaries and what

[3] The International Food Loss and Food Waste Studies Group: https://foodwastestudies.com/join-the-discussion/

kind of papers we were looking for. This garnered several responses, especially for very recent estimates, which were then reviewed for suitability if the paper had not already been identified.

The research group was also the avenue by which contact was made with a researcher, Zhengxia Dou, whose recently published study (Dou & Toth, 2020) similarly focuses on direct measurements of food waste. Prof. Dou very kindly shared the reference list of this unpublished study. This comprehensive list of references served as both a helpful avenue to find some more studies but also a confirmation of the approach taken up to that point, as most of the studies relevant to food waste quantification had already been identified.

Key food waste researchers were also contacted individually to see if they were aware of additional data. This included Felicitas Schneider, Gang Liu, Gustavo Porpino and several regional and sector specialists at UNEP and FAO.

2.1.3 Limitations with search method

No search will be 100% effective. This wide-ranging searching strategy was designed to obtain the maximum number of relevant studies within the constraints of the project.

As previously mentioned, resource and time constraints meant it was not feasible to evaluate every single page of search results from the Google and Google Scholar searches, given both the large number of results and large number which were not relevant for our purposes here. Whilst it is reasonable to assume that notable references should be accounted for through the combined search and 'snowball' references method, it is possible that a small number of studies exist which were not found. For example, many studies were identified through other strands of the search strategy that were primarily studies evaluating Household *solid* waste rather than *food* waste, but, on closer inspection, disaggregated food waste from other organic wastes, allowing a food-waste estimate to be obtained. Many of these were at a subnational level. More studies of this nature may exist that were not identified. Furthermore, there may be other 'categories' of study containing relevant food-waste data that were not identified.

Although studies from a wide range of countries in a range of languages were obtained, there remains the possibility of geographic bias. We hope that the publication of this study helps understand whether there are studies, currently missed by this searching strategy, from poorly represented countries and regions.

2.2 Data Extraction and Adjustment

This section contains details on:

- The information recorded from each study (2.2.1)
- Adjustments made to data to increase comparability (2.2.2)
- Classification of estimates based on our confidence in the estimates (2.2.3)
- Decisions relating to whether studies were included in the calculations (2.2.4)

2.2.1 Data extraction

For each relevant study identified, the core information searched for and extracted (beyond bibliographic information) was as follows:

- Geographic boundaries
- Time of study
- Sectors covered
- Methodological details, including sample size, length of sampling and representativeness
- A share estimate (e.g., *x*% of household solid waste was food waste, or *y*% of total national food waste occurs in a particular sector).
- A total mass estimate for that sector and geography
- A normalised (per capita) mass estimate for that sector and geography
- The share of food waste which was considered edible or avoidable
- The share of organic waste which was food waste
- The waste destinations, particularly if included in the paper estimate was some waste which goes to an avenue not considered waste in the FWI

Very few studies had all of the above information: in some cases, it was not relevant to the scope of the study; in others the information was not reported in the publication. As much of the above list as possible was captured.

All total and normalised mass estimates were input using the measurement scale used in the paper (e.g., million tonnes / year, g / capita / day) and then adjusted for this study to a single comparable figure for total mass (tonnes / year) and normalised mass (kg / capita / year).

In some cases, the original mass value was presented as multiple numbers (such as edible and inedible waste separately) or required some calculation (such as where daily *total* waste generation is presented alongside a percentage which was food waste, allowing daily food waste to be derived). These calculations were carried out to ensure comparable figures.

We searched within papers for estimates of 'food waste', sometimes referred to as 'kitchen waste'. Definitional consistency was an issue in several papers: many studies used the terms 'kitchen waste', 'organic waste' and 'food waste' interchangeably within the same paper. In some cases, the term 'organic' would be used but only foodstuffs listed in the table describing the categories, on other occasions the term 'organic' would be used in a table or graph with 'food' being used to label the same category elsewhere in the paper.

To deal with these problems, we used the definitions applied by the authors. If they labelled a category as food or kitchen waste (without further elaboration on the definition), this was understood to mean edible and inedible food waste. In addition, most authors defined garden/yard waste as a separate category. This presents the most notable bulky organic waste stream outside of food, so its inclusion as a separate category increased confidence that what was labelled as 'food' was, indeed, food waste.

It remains possible that other, non-food wastes have been included in these categories: sanitary waste such as nappies and animal excrement in particular vary substantially in the regularity with which they are disaggregated in waste compositional analyses, and it is often unclear what category they have fallen into ('organic', 'general', 'other' etc.). This is a limitation of the estimate which unfortunately could not be avoided: we have tried to work as best we can with the data available from the papers. For a discussion of the organic waste studies which were excluded, see section 2.2.4.2.

2.2.2 Data Adjustments

There are a number of different ways in which food waste can be measured and reported. This presented a challenge as we were aiming to produce results which are as comparable across estimates. In order to make the data as comparable as possible, a number of adjustments were carried out to specific datapoints to account for time difference, measurement boundaries or measurement bias. These are outlined below. Some of these adjustments add extra uncertainty to estimates, reducing our confidence (see 2.2.3).

2.2.2.1 Population statistics

In order to create a single comparable food waste baseline, all estimates were normalised to a single year: 2019. To do this, we assumed that per capita food waste has held constant since the time of the estimates identified. This enabled us to use 2019 population statistics for the purposes of scaling per capita waste estimates to country-wide estimates and global food waste extrapolations. All data on population and other relevant national indicators was downloaded from data.un.org on 03/09/2020.

Some of the identified studies did not present waste as a *per capita* estimate, but rather *total mass* for a specific sector and location. To enable scaling, these estimates were normalised to a per capita estimate. For this, the same UN data source was used. As this data source does not provide a continuous time series, a linear interpolation was made between available data points to infer the population of intermediate years. This allowed an estimate of population in the year of each study to be used to normalise the total mass estimate. Once expressed as a per capita waste estimate, it was possible to scale these by 2019 population figures to form a country estimate.

A worked example: Japan's total waste estimates (Food Industry Policy Office, 2017) come from MAFF survey data for 2014. Population data was available from the above source for 2010 and 2019 only; 2014 population is inferred by linear interpolation between these two datapoints. The total mass estimates are used to form per capita estimates from this figure. This normalised, per capita figure is then multiplied by the 2019 population to form an estimate for 2019.

Some studies did not provide information as to the year the observation took place, or what year the waste estimate refers to. In these cases, the year of observation was assumed to be two years prior to the year of publication. In the case of subnational studies presenting total mass rather than per capita, the population as listed in that study or paper was used to ensure consistency in the boundaries used to define the area.

2.2.2.2 Edible share adjustment

Food can be divided into the share which is edible by humans (such as the flesh of a fruit or animal meat) and that which is inedible (such as onion skins, banana peels and animal bones). Due to the inedible fraction, a world without some degree of food waste is unlikely: eating a banana often leads

to wasting its skin. A reduction in the edible share will have a knock-on effect on the amount of inedible waste (fewer bananas wasted may mean fewer bananas are grown to meet the same demand, which may lead to fewer skins wasted in total). As a result, general policies and interventions which target food waste are usually targeting the edible share. Many studies therefore focus their analysis on the edible fraction of food waste as this is the portion which is directly targeted by food waste reduction campaigns.

The definition of food waste used for the purposes of SDG 12.3 encompass both the edible and inedible fractions of waste. In order to compare studies which only record the edible waste with those which record edible and inedible parts, the omission of the inedible fraction required adjusting. Many studies report *both* the edible and inedible waste (or the similar distinction between 'avoidable' and 'unavoidable' waste). These were taken to mean the same thing: whilst there are subtle differences between 'avoidable' and 'edible', they were considered sufficiently comparable.[4] In the cases where 'possibly avoidable' was measured, this was divided into two and allocated evenly between 'avoidable' (edible) and 'unavoidable' (inedible)[5]. The share of waste which was edible or avoidable was then converted into a percentage share. From here, it was possible to create sector-specific scaling figures through the following calculation:

$$Sector\ edible\ scaling\ factor = \frac{1}{Sector\ average\ edible\ share}$$

Table 4: Edible share of waste only adjustment figure

	Household	Food Service	Retail
Number of studies	17	8	4
Number of countries	16	7	4
Average edible share	49%	66%	85%
Scaling factor	2.04	1.50	1.18

2.2.2.3 Household Diary adjustment

Many countries have used food waste diaries – where a household member weighs and documents each incidence of food waste for a period of time – as a way of measuring household food waste. However, as is pointed out in Quested et al. (2020), diaries "substantially underestimate HHFW". They identify four main factors for this: behavioural reactivity (people behave differently and waste less in the study period); misreporting (not all discarded items are recorded); measurement bias (the respondents do not weigh all their waste) and self-selection bias (those completing a diary are different from the wider population). Nonetheless, there are many reasons why a diary may be a suitable study method: it can be cheaper to carry out than a waste compositional analysis; it may cover all disposal paths not included in a solid waste study, such as down a sink or home compositing; it can provide the *causes* behind given instances of waste and how they relate to specific food products and it can be combined with demographic or attitudinal surveys to find correlates to increased food waste generation. A recent paper by Withanage et al. (2021) provides a good overview of when different methodologies for measuring food waste are most applicable.

For our purposes, the incomparability between diaries and waste compositional analysis presented a problem as it would indicate that some countries or territories have lower waste than others when

[4] (For a discussion of these definitions, see Section 2.1.2 of: WRAP, 2018)

[5] The assumption behind this decision was based on the analysis in (WRAP, 2018)

this may in fact be a result of methodological differences. In order to correct for this, therefore, the scaling factor presented in Quested et al. (2020) was used. They identify five studies where diary estimates of HHFW can be directly compared to waste compositional analysis data and the amount by which diaries underestimate actual waste (average: 30.2%). This is then converted to a scaling factor as follows:

$$Diary\ scaling\ factor = \frac{1}{(1 - degree\ of\ underestimation)}$$

which, when calculated using the average underestimation of 30.2%, comes to 1.43 (rounded). A preliminary analysis of the (unadjusted) per capita waste data in our database suggested a similar margin of error, giving us some increased confidence in the use of this figure.

Studies which calculated household food waste through a diary methodology were therefore multiplied by this scaling factor to get an adjusted figure of waste generation.

2.2.2.4 Household Diary and edible adjustment

In a limited number of cases (see Table 5), Household studies employed a food waste diary methodology and measured only the avoidable or edible waste. In these cases, *both* adjustment factors are applied through multiplication. This decision was felt to be justified in that the reasons each of these methodological details requiring adjustment were different: reporting edible waste only is an issue of measurement boundaries, food waste diaries by contrast underestimate due to bias.

Together, the adjustment factors for Household diary (1.43) and inedible waste (2.04) become a total adjustment figure of **2.92**. This nearly triples the initial estimated waste. Whilst this seems to be a large increase, the final per capita estimates obtained from this adjustment do not become unreasonably high, in fact they become more comparable with other countries (see sections 2.5.3 and 2.5.4 of the main FWI report) which would suggest that the level of adjustment is reasonable:

Table 5: Estimates adjusted for diary and inedible parts

Country	Reference	Adjusted kg / capita / year
China	(Li et al., 2021)	21
Finland	(Katajajuuri et al., 2014)	67
France	(ADEME, 2016)	85
Spain	(Caldeira et al., 2019)	78

2.2.2.5 Aggregating socioeconomic groups

In a few papers, particularly JICA papers and ones following a similar methodology to establish household waste in an urban area, households were grouped into multiple socioeconomic groups (mostly high, medium and low) and sampled based on that. As a result, the study would generate multiple shares of food waste in the residual waste and multiple daily waste generation factors. In some cases, the studies aggregated this information themselves based on the relative population shares of those socioeconomic groups, but in some cases did not.

Where multiple estimates needed aggregating for the purposes of providing a single per capita datapoint, the estimates for each socioeconomic group were weighted based on that socioeconomic group's share of the total sample. It was therefore assumed that the sampling attempted to mirror the wider population; in many cases, this was explicitly described as the intention but in other cases it was not mentioned at all. Therefore, there is a risk that some datapoints have been aggregated in

a way which does not reflect the distribution of socioeconomic groups in the country or territory in question. This is a limitation but not one easily avoided: typically, studies in sub-national areas used *ad hoc,* relative definitions of the socioeconomic groups based on variables such as income, predominant housing type in an area, classification of a neighbourhood etc. As a result, finding comparable data which could have been used to weight these estimates more accurately was not viable, and the share of sample size was taken to be approximate to share of population.

The available disaggregated socioeconomic data and its implications for the report are discussed in Box 1 of the main FWI report.

2.2.2.6 Aggregating study periods

In some cases, studies were carried out in multiple time periods to estimate seasonal variations, such as between rainy or dry seasons. In cases where this was averaged by the author to create a yearly average, this value was taken. In cases where the author did not average the seasonal variation but instead presented them as multiple tables or datapoints, a simple mean average was taken of these generation figures. Whilst this would not be quite as accurate as weighted averages which account for season lengths, it was not considered to make a substantial difference and in many cases food waste was quite consistent, whereas some other wastes (such as garden) saw substantial variation.

2.2.2.7 Removing non-waste destinations

For a small number of studies, other adjustments were possible based on information regarding disposal routes:

Food waste destined for **animal feed** is not considered waste as part of the FWI. A small number of studies had estimates of the destinations for waste including that share which was going to animal feed. In some cases, the authors had already removed this from the estimate which was reported as waste. In other cases, the share going to animal feed was used to adjust the waste estimate used in the present study. Similarly, food which is **donated** to charitable organisations for human consumption is not considered waste and was removed where the authors had not already done so.

For the household sector, in order to ensure comparability, food waste disposed via the sewer was removed where possible from studies. This applies to a very small number of studies which detailed this information. This was primarily to improve comparability, as the majority of household studies were explicitly conducted on the 'solid' waste streams (e.g. residual waste, separate food waste collections, etc.). Sewer waste is included under the FWI definition and is included under Level 3 reporting (see Section 3.4 of the main FWI report).

2.2.3 Data Classification

All datapoints which fit the above criteria were considered for the purposes of extrapolating estimates of food waste. However, the studies varied in their methodologies and many were adjusted to improve comparability. These factors impact our relative confidence in the robustness and accuracy of each datapoint and, therefore, each estimate for a specific country.

To reflect our confidence in the datapoints, studies were grouped into two 'tiers' which correspond to whether the estimate for a country is *High* or *Medium* confidence (for countries without identified estimates and therefore requiring extrapolation, confidence levels are either *Low* or *Very Low*, see 2.3). These correspond to methodological detail: datapoints in which we have higher confidence involved more accurate quantification, estimated waste for the entire country and had a sufficient, representative sample size. The datapoints in which we have *Medium confidence*

correspond to some studies which required adjustment, namely studies focusing on a specific sub—national area, only measuring edible waste or using diaries. Similarly, referenced figures which were unfindable, had unclear methodology or small sample sizes were typically classed as *Medium confidence*. Where a *High confidence* paper was available for a specific country and sector, this was used and any *Medium* confidence papers for the same country and sector were excluded from further analysis. A full description of the boundaries between confidence levels for each sector follows.

It should be noted that confidence ratings are an assessment – based on our understanding of the study – of how robust the estimate of food waste is for tracking food waste in the given country, not a judgement on the quality of the study undertaken. In many cases, food waste measurement was *not* an aim of the original study. Hence many good studies will be classified at a *Medium* confidence level (or even excluded from consideration altogether) as the aims of the paper did not include national food waste tracking.

To see the full list of included datapoints and their confidence level, see Section 3.

2.2.3.1 Sub-national studies

A number of studies, particularly in the Household sector, measured food waste in part of a country (e.g., a state, province or city). These sub-national studies include those with a mixture of urban and rural (such as Flanders, Belgium (Flemish Food Supply Chain Platform for Food Loss, 2017)) and studies exclusively in an urban area (such as Beirut, Lebanon (Chalak et al., 2019)). In these cases, applying the per capita waste figures for each sector to the population of the whole country would assume comparability between regions and that rural and urban waste generation are comparable, large assumptions which are likely to be inaccurate. Very few studies focused on rural waste, meaning it was not possible to form an estimate of the variation between urban and rural waste (for one example of a study including both rural and urban households, see JICA (2015) in Gujranwala, Pakistan).

As a result, all studies which were at a sub-national level were classified as *Medium confidence* with regard to an estimate of *national* waste, regardless of whether they met the methodological criteria for each sector (2.2.3.2, 2.2.3.3, 2.2.3.4) Where a sub-national estimate was identified alongside a national estimate for the same sector, the national estimate was prioritized unless there was some methodological reason to exclude it.

All studies are, to some degree, local in their sampling. When a study was in a specific locality but the authors described this as being representative of the wider country and the authors weighted their results by national distributions (of income, household size etc.), this was considered a 'Nationwide' rather than 'Sub-national' study, and therefore could be considered a *High confidence* estimate (Hanssen et al. (2016) in Norway is a notable example here).

2.2.3.2 Household

For the Household sector, we have higher confidence in studies which involve the direct weighing and measurement of food waste by an external researcher. This includes waste compositional analyses, direct weighing of food-only waste streams and papers which combine waste compositional analysis with other data for scaling purposes.

Within studies which directly weighed waste, sample size was used as a further determinant of our confidence in the estimate. The figure of 700 household 'waste-days' (households sampled per day * number of days sampled) was used as a cut-off point. Above this, nationwide studies were

considered *High confidence*, all papers under this were *Medium confidence*. In some papers, the duration of sampling was not specified (see Grover & Singh (2014) in Dehradun, India, for example). This ambiguity meant it was considered prudent to provisionally classify these as *Medium confidence* unless more information were to become available. Choosing a boundary to classify studies is an imperfect science and there is not a single answer as to whether a larger, more time limited or smaller, longer sample is preferable for estimating food waste. The 700 waste-day figure was chosen because it equates to 100 households sampled for a week-long period, which was a common sampling approach and seems a reasonable benchmark for a sufficient sample within resource constraints.

Other methodologies required adjustment to be comparable, namely food waste diaries or those which measured only edible food waste (see 2.2.2.2 and 2.2.2.3). As a result of the uncertainty stemming from these adjustments, the final waste estimates we use were considered *Medium confidence*.

Additionally, a number of papers referred to statistics or figures without presenting methodological detail or from sources which we were unable to trace further than the secondary reference. In many cases this was due to unclear referencing or citing papers which could not be found based on online searches. If unfindable, but referenced in a publication which was peer reviewed, by a reputable organisation or governmental publication, or a reference of a governmental publication which could not be found, these datapoints were included. These papers were classified as *Medium confidence* based on the uncertainty stemming from being unable to view the primary material. In a project with additional time or resource these data sources could potentially be found, providing enough information to reclassify the data.

2.2.3.3 Food Service

The Food Service sector is a notably problematic sector for the generation of *High confidence* estimates of the entire sector. Many studies provide a robust measurement of a single establishment or subsector of establishments (such as hotels, or university canteens) but adequate collation and scaling of a range of subsectors is needed to form a nationwide estimate. As a result, the overall level of confidence is lower than in the Household estimates.

We judged ourselves to have *High confidence* in waste audit studies which met two criteria:

- Sufficient sample size, auditing waste in at least twenty establishments
- Coverage of establishments in both the commercial (such as hotels and restaurants) and non-commercial sector (such as schools and hospitals)

Many authors identified that chefs and managers were resistant or openly hostile to the prospect of independent waste audits. In addition, some commercial bodies (particularly larger restaurant chains or catering providers) may already measure their waste. As a result, surveys of businesses or chefs are often employed. Surveys of chefs with over 100 respondents or carried out by an authoritative trade or governmental body, and covering both commercial and non-commercial, were also considered *High confidence* (notably, Danish Environmental Protection Agency (2014) from Denmark). It should be noted that there is insufficient detail in papers to say with confidence that waste was directly measured by Food Service organisations prior to responding to surveys, or indeed to submitting their data to governmental auditors. Given the commercial imperative to measure waste, but also the difficulty in initiating researcher-led audits, this uncertainty was considered acceptable.

Estimates in which we only have *Medium* confidence relate to those which had any of the following limitations:

- Only measured edible waste and therefore required adjustment (as per 2.2.2.2)
- Were referenced in secondary peer reviewed or governmental publications but with an original source we were unable to trace or access
- Cover Food Service establishments in either commercial or non-commercial sectors only

The inclusion of this third category of paper, which represents an 'incomplete Food Service' estimate, means there is a downward bias to the results leading to **substantial underestimation** and that actual waste across the Food Service sector is likely to be significantly higher. Some of the challenges with Food Service measurement are discussed in Box 4 in the main FWI report.

The Food Service estimates have big limitations for three reasons:

Firstly, looking at waste in per capita terms may not be the most suitable metric for this sector.

Secondly, the sheer breadth of the out of home environments in which food waste could be generated creates problems for quantification. Section 3.2.1 in the main FWI report demonstrates the wide range of establishments which could be considered under the Food Service sector. Measuring waste in all these locations is practically very difficult, and the relative scale of each subsector will vary significantly based on the national context. This leads to an inconsistency in scopes: to our knowledge, only the US (U.S. Environmental Protection Agency, 2020) and UK (WRAP, 2020) estimates include waste in sports stadia. Balancing an accurate estimate of out of home waste with the limitations of practicality and resources remains a challenge.

Thirdly, food waste going down the sewer is inconsistently measured. In some settings, this could be considerable.

2.2.3.4 Retail

Retail, like Food Service, has the problem of being considered commercially sensitive data, making it more difficult for researchers to carry out audits or access existing records which may be carried out internally. Whilst some supermarkets are publishing their data, a sufficient number of supermarkets in any given country needs to do so for this to give insight into national waste.

The inconsistency with which sample information was provided meant that it could not be used to form an assessment of confidence in the estimate. Instead, differences in methodology were grouped. The *High confidence* estimates refer to those in which a waste audit was carried out by or with the assistance of external researchers, whether weighing or using supermarket scanning systems, and those estimates which involved the disclosure of internally collated supermarket data to a relevant body, whether governmental surveys (for Japan, see Food Industry Policy Office (2017)), industry agreements (for the UK, see WRAP (2020)) or other forms of public disclosure.

The estimates which were judged *Medium confidence* included studies with less transparency or potentially less robust data, including any of the following limitations:

- Interviews with supermarket representatives where it is unclear whether the estimates provided came from direct measurement within the retail establishment
- Estimates referenced in secondary peer reviewed or governmental publications but with an original source we were unable to trace or access
- Estimates which only measured edible waste and therefore required adjustment, as per 2.2.2.2.

2.2.4 Rejected estimates

Below is a brief description of the two primary categories of papers which were narrowly rejected but could be applicable in other scenarios for forming very rough, 'order of magnitude' estimates of food waste.

2.2.4.1 MSW Papers

There are many papers which document waste compositional analyses which we were unfortunately unable to consider here due to the sectoral uncertainty around them. Papers which analysed the MSW of a geographical area often disaggregate food from other organic and biological waste, however, the uncertainty of the origin source of the waste means it could not be said with any certainty what was being measured.

MSW will typically be dominated by household waste, but other wastes from litter bins on the streets, commercial waste from small businesses including restaurants, retailers and street vendors may make their way into the MSW. Furthermore, not all households or businesses will necessarily have access to MSW collection rounds: their waste may be processed through informal or illegal routes. As a result, papers which analyse MSW without disaggregating the source are difficult to use in the current study. This includes information about waste samples from landfills or waste transfer stations.

There were a few MSW-based papers that provided usable estimates. These were typically when a *residential* solid waste specific estimate was provided (i.e., disaggregation of the total MSW estimates). To provide an example: Denafas et al. (2014)'s waste compositional analyses in four East European cities had three MSW estimates which were unusable and one residential solid waste which was usable. For Kaunas, St Petersburg and Boryspil, the methodology describes taking a waste sample from a transfer station or landfill. This sectoral uncertainty means it could not be used. By contrast, the sample taken for Kutaisi in the same study was specifically a sample from residential areas. By virtue of being residential only, it can be used as an estimate for household. This example demonstrates how the specificities of method and where the sample was taken could be the difference between inclusion and exclusion.

Some MSW papers claimed to be looking at the household share of MSW, without clarifying how exactly that was determined (see Zhang et al. (2018), for example). In these cases, the claims of the researchers have been trusted and they have been codified as Household estimates, although the uncertainty means they are classified as *Medium confidence* (see 2.2.3).

By not including MSW papers, we are not able to use the insights provided by another big source of waste data: the World Bank's 'What a Waste' dataset (Silpa Kaza et al., 2018). This was searched within for possibly relevant papers (see 2.1.2), but for the reasons described in this section, the data could not be used directly.

2.2.4.2 Organic estimates

There were several papers, particularly in the household sector, which evaluated only the total *organic* rather than food waste. The organic fraction could contain a wide range of materials, including food, garden (green) waste, wood and leather. The relative fractions of these materials within the total organics will depend on a range of factors, most notably around garden waste, including: presence of gardens, feeding of domestic animals. climate (affecting the amount of growth) and whether the geographical area in question provides collection of garden waste (e.g., for industrial composting or anaerobic digestion).

For studies where there was no disaggregation of total, we considered the possibility of calculating the approximate amount of food waste from the total organics. This could be achieved by taking the average percentage of food waste within total organics from studies that did provide this information and applying this average to those studies that only provided total organics.

Two problems arose in applying this method:

- The average percentage of food waste in total organics varied widely between studies: the lowest value was 24%; the highest 98%. (Mean = 81%; standard deviation 17%). This wide variation likely reflects the factors affecting garden waste mentioned above and makes applying an average value to obtain even an approximate estimate of food waste in a county with an organic-only estimate problematic.
- If food waste estimates were to be estimated using this method, they are much more scattered than those directly measured (even with other adjustments): of the 14 studies identified that this method could be applied to, three of the resulting estimates of households food waste would be conspicuously high (greater than 150 kg / person / year) and another would be less than 1 kg / person / year). This is further illustrated by the standard deviation: for the organics-based estimates (62 kg / person / year), it would be around twice that of other estimates used.

Furthermore – and as mentioned in 2.2.1 – terminology used around these concepts is not standardised. Some studies use the terms 'kitchen waste', 'organic waste' and 'food waste' interchangeably within the same paper.

For these reasons, we deemed that estimates obtained in this way (i.e., applying the average percentage of organics waste which is food to studies with a total 'organics' category) insufficiently accurate. We believed that it would be slightly more accurate to extrapolate from similar countries than to use these calculations.

2.2.4.3 Surveys

Household surveys in which a representative of a household is tasked with recalling the waste they or their household has generated over a period of time were considered too inaccurate and incomparable with the other measurement methods considered here. As a result, no studies which *only* distributed a survey to households were included. (Many studies distribute a survey alongside a diary or waste compositional analysis.)[6]

By contrast, surveys of organisations such as manufacturers, managers of retail organisations or restaurant chefs were considered sufficient for inclusion. Whilst they still have problems typically tied to underestimation (ADEME (2016), in France, demonstrates this point of substantial chef underestimation when compared to observation), the commercially sensitive nature of the information makes direct external observation more difficult. The commercial incentive to reduce waste means many companies may have internal procedures which would inform survey responses, making them more accurate than household estimation via surveys. However, the quality of opaque internal measurement is hard to verify: this problem is true both for researcher surveys and governmental reporting requirements (see Sections 2.2.3.3-2.2.3.4).

[6] (C Cicatiello, 2018; Delley & Brunner, 2018; Giordano et al., 2018; For discussions on survey methodology, see: van Herpen et al., 2019)

2.2.4.4 Superseded studies

In order to make our estimate as relevant for 2019 as possible, we have used the latest available estimate of food waste available in each country. As previously mentioned, a few countries have repeated estimates of food waste to provide a time series (such as the UK (WRAP, 2020) or the Netherlands(The Netherlands Nutrition Centre Foundation, 2019)). When an estimate for which we have *High* confidence was available, this was taken and prior studies were not considered.

In the cases of *Medium confidence* estimates, if a study was a nationwide, direct repetition of a prior study for comparison purposes (such as Hungary (Kasza et al., 2020), which uses a diary methodology) only the most recent estimate was taken. In the cases where multiple *Medium confidence* estimates exist but they are not directly comparable to one another (such as Iraq (Al-Maliky & ElKhayat, 2012; Al-Mas'udi & Al-Haydari, 2015; Al-Rawi & Al-Tayyar, 2013; Sulaymon et al., 2010; Yasir & Abudi, 2009) which has distinct studies across a range of cities) the average of all of the relevant datapoints was taken to form the estimate.

As a result of this 'superseding' process, many studies are excluded from the calculations due to their being older than comparable studies. Therefore, the total number of food waste quantification studies originally considered is much higher than those in the final calculations. Similarly, due to prioritising *High confidence* estimates (2.2.3), all *Medium confidence* estimates in countries and sectors with *High* estimates were superseded, meaning a wealth of additional sub-national estimates and Household diary studies exist beyond the final list of estimates.

2.2.4.5 Other unsuitable studies

Alongside the above categories and papers which were incompatible with the methodological requirements (2.1.1), a number of studies required closer consideration before being excluded. In particular, this was the case if studies were more qualitative or centred around a case study with a very small sample, such as a single restaurant or a handful of households, usually measured for testing methodologies, or lacking the information necessary to scale the information to a national estimate. Below is a small sample of excluded studies with the reasons for exclusion, to offer an insight into studies which fell narrowly under the line of usability:

- A study on household waste from rural Czechia, whilst very detailed and including an ethnographic study, had a sample of seven households over the period of two weeks each year across two years. As each year amounted to fewer than 100 'waste days' (number of households sampled * days of waste generation sampled), this was considered too small a sample (Sosna et al., 2019).
- Numerous studies, including for example by JICA in Pakistan (JICA, 2015), collect a reasonable waste sample (ten restaurants and institutions over a week) but the waste is presented only in terms of the waste per establishment or member of staff. Such information can be very useful and allow other forms of comparison between countries. However, for our purposes extensive data on meals consumed out of home, the number of restaurants in a country etc. would be required to scale the information to national estimates. As a result, this data was not usable in our estimates.
- A study of a supermarket in Viterbo, Italy, focused on food that is recovered for charitable purposes. 'Rescued' food for human consumption is not considered waste, and food taken by a charitable organisation is not a proxy for waste generation. Furthermore, this study looks only at a single establishment and extrapolates based on floor size. This was considered too small a sample to have confidence in the conclusions at a national level (Cicatiello et al., 2016).

2.3 Calculations: Quantifying food waste in each country

This section details the calculation methods used to obtain an estimate of food waste for each country in the world, for each of the three sectors under consideration.

Multiple methods were trialled to explore their appropriateness to meet the objectives of this study. The method in this section was assessed to be the most accurate and most appropriate given the nature of the data collected. Other methods are outlined in (2.4), with discussion of why they were deemed less appropriate to this study.

The method used for Household is different from the other three sectors, so is presented separately. This reflects the low data coverage for non-household sectors outside the HIC bracket. This data scarcity means that the estimates for the non-household sectors have **low accuracy** and therefore have a confidence level of *Very Low*. This reflects the substantial assumptions required to obtain these estimates. They are intended to give an approximate indication of the scale of the problem where these assumptions hold true. Without more data, we cannot say with confidence whether these estimates under- or over-state the true scale of the food waste problem.

2.3.1 Household

There are two broad approaches to obtaining a household-food waste estimate for a given country. This depends on whether a country has an estimate of food waste (classified as either *High* or *Medium* confidence, see 2.2.3.2) or no usable data for quantification purposes.

- **Countries with data:** For countries with a single usable estimate of household food waste, this is taken as the estimate for that country. When a country has multiple estimates (e.g. multiple household studies have been undertaken and we have a similar level of confidence in each), the average (mean) of those estimates is taken. If *High* confidence estimates existed for a country and sector, any *Medium* confidence estimates were removed, so averaging only happens at the same confidence level. See 2.2.4.4 for detail on when studies were superseded and when they were grouped. Only nationwide studies are considered *High confidence* to reduce possible bias from sub-national studies overrepresenting specific population groups, although sampling methodologies and in-country variation may still lead to uncertainty in the results.

- **Countries without data:** For countries without a usable study, we calculate an extrapolation using data from similar countries. For this calculation, two figures are calculated, and the average taken:

  The average waste (kg / capita / year) for data points from all countries with estimates in the same *income group* as the country in question (using World Bank classification)[7] and

[7] As previously mentioned, income groups refer to World Bank classification, for the 2021 fiscal year. There are four categories: Low-income countries (LIC), defined as those with Gross National Income (GNI) per capita of $1,035 or less; lower middle-income economies (LMC), with GNI per capita between $1,036 and $4,045; upper middle-income economies (UMC) with a GNI per capita between $4,046 and $12,535; high-income economies (HIC), those with GNI per capita of $12,536 or more.

The average waste (kg / capita / year) for data points from all countries with estimates in the same *region* of the country in question (using UNSD sub-region). For a list of all countries and regions, see Appendix 4.

These two figures are averaged (i.e., combined with equal weight) to generate an estimate for the country:

$$Extrapolated\ Estimate = (Avg.of\ income\ group * 50\%) + (Avg.of\ region * 50\%)$$

All averages are means. If there is no regional average, the income group average alone is used to inform the extrapolated estimate.

Due to the small number of estimates in Low-Income Countries (LICs), the income group average for LICs is calculated by averaging the data points for Low-Medium Income Countries (LMCs) and LICs into a single figure. Table 6 displays the average per capita waste by income group.

Table 6: Average Household food waste, by World-Bank income group

WB Income Group	kg / capita / year	Number of countries with estimates
HIC	79	28
UMC	78	12
LMC	91	10
LIC	*97**	2(+10)

** Due to the small number of LIC studies, the LIC average waste is calculated as the combined average of LMC and LIC, hence a total of 12 countries informing the average. There is insufficient data to make conclusions about food waste in low income countries.*

Table 7 displays the average per capita waste by region. For a discussion of some of the specific regions and the papers used to inform the estimates, see Section 2.4 of the main FWI report. Whilst the calculations are based on the averages presented in

Table 7, the small number of datapoints for many regions and differences in methodology mean that drawing meaningful comparisons from differences in this table is not possible and should be avoided.

Table 7: Average Household food waste, by region

Region	kg / capita / year	Number of countries with estimates
Southern Asia	66	4
Southern Europe	90	5
Northern Africa	n/a	0
Polynesia	n/a	0
Sub-Saharan Africa	108	8
Latin America and the Caribbean	69	4
Western Asia	110	6
Australia and New Zealand	81	2
Western Europe	65	6
Eastern Europe	61	3
Northern America	69	2
South-eastern Asia	82	3
Eastern Asia	64	2
Northern Europe	74	7
Melanesia	n/a	0
Micronesia	n/a	0
Central Asia	n/a	0

Because the income groups typically include more countries than the regions, in nearly all cases the country has more estimates from similar income level countries than it does for countries within its region. As a result, by applying the average of the region and income group evenly, each regional estimate is given more weight than economic group estimates. The extent of the bias towards regional estimates depends on the number of papers in each category. This is considered justifiable as there are more likely to be regional similarities in diet and food culture (and thus food waste) than there are between geographically dispersed countries of similar income.

Countries which are in both the same income group and region are counted twice, once in the regional and once in the income average. As a result, this 'double-weights' the data from these countries. This is again considered justifiable as the data is coming from countries most alike to that in question.

We assess our confidence in the extrapolated estimates based on the number of countries which inform the extrapolation. None of the extrapolations are considered *High* or *Medium* confidence estimates, as these classifications are reserved for countries in which a study was identified. Extrapolations with *low* confidence are those which are informed by *at least* ten countries in total of which *at least* five must be countries from the same region. These are based on *countries* rather than *datapoints,* so even if a country in the same region had five studies informing its estimate, this would only count as one for the purposes of extrapolation. All extrapolations in LICs are *Very Low* due to having to use averages largely derived from LMCs. For a summary of confidence ratings, see Section 2.3.3.

2.3.2 Retail and Food Service

For non-household sectors (i.e., Retail and Food Service), the data coverage geographically and across income levels is insufficient to fully replicate the approach taken for households. There are three ways in which country estimates have been made:

- **Countries with data:** Similar to the method used for households, if a country has usable estimate(s) of food waste in that sector, this is taken as the estimate for that country. As with Household, when a country has multiple estimates, the average (mean) of those estimates is taken. Where a country has a *High* confidence estimate for a sector, this is prioritised and *Medium* confidence estimates are not included. These are classified as either *High* or *Medium* confidence depending on the method and scope of the study (Sections 2.2.3.3 and 2.2.3.4).

- **High-Income Countries without data:** For HICs, there is sufficient data to extrapolate to other HICs without data. This extrapolation uses the average (mean) per capita waste of HICs with data. There is insufficient information in most regions to support the use of regional estimates in this extrapolation. These estimates are classed as 'low' confidence.

- **Other countries without data:** For UMCs, LMCs and LICs the average per capita waste for all countries with estimates is taken. This amounts to a very rough global average being used for the extrapolation. These estimates have a *Very Low* confidence classification.

As previously mentioned, the method for non-HICs is will result in estimates with **very low levels of accuracy**. For these countries, the global average used for extrapolation is mainly based on data from HICs, which may not be suitable proxies, hence the *Very Low* confidence classification.

Table 8: Average per capita waste by sector, HIC and all countries combined

	Food Service		Retail	
	Average (kg / capita/ year)	No. of countries with estimates	Average (kg / capita / year)	No. of countries with estimates
HIC	26	18	13	20
Global	28	23	16	23

2.3.3 Calculating Confidence per sector

Four confidence brackets are applied. High *and* Medium *correspond to when a country has an existing estimate, with classification of that estimate corresponding to the boundaries set out in section 2.2.3.* Low *and* Very Low *confidence are calculated differently for household and non-household sectors, as outlined in Sections 2.3.1 and 2.3.2 respectively. This categorisation is summarised in the*

Table 9.

Table 9: Description of confidence classification in this study

	When the classification has been used for…		Approximate confidence interval	Suitable for tracking?
	… Household	**… Food Service and Retail**		
High Confidence	If there is a country-specific high confidence estimate		Often in range ±10-20%. See specific study for value or data to calculate CI	Highly likely
Medium Confidence	If there is a country-specific medium confidence estimate and no high confidence estimate		Often in range ±20-50%. See specific study for value or data to calculate CI	Possibly for larger changes in FW, although study may have potential for higher accuracy and / or comparability with other countries
Low Confidence	Extrapolation from estimates from at least 10 similar countries, of which at least five are in the same region	Extrapolation with sufficient estimates in income classification (i.e., for HIC countries)	Around ±50%	No – but may provide approximate estimate to inform FW-prevention strategy
Very Low Confidence	All others: Extrapolation from few than 10 estimates or fewer than five from the same region	All others: extrapolation for non-HIC countries	At least ±50%	No – but may provide very approximate estimate to inform FW-prevention strategy

The confidence rating in this report is not a judgement on the quality of the study undertaken. It is an assessment – based on our understanding of the study – of how robust the estimate of food waste is for tracking food waste in the given country. In many cases, this was not an aim of the original study. Hence many good studies will be classified at a *Medium confidence* level (or even excluded from consideration altogether) as the aims of the paper did not include national food-waste tracking.

2.4 Additional extrapolation methods considered for Household sector

Several different approaches were trialled for obtaining global estimates of food waste in each sector. The most appropriate approach given the data is described in 2.3, with results in Section 2.4.3 of the main FWI report. However, those approaches trialled but rejected are listed below.

Firstly, it was important to note that had significant correlations been observed between levels of food waste and potential explanatory variables for which there is good national coverage (such as GDP per capita), that this relationship could be used to build a regression model, and extrapolation to countries without data be informed by this model. However, none of the sectors had a discernible relationship with a nation's GDP / capita. In fact, Household waste, which might be expected to be the one with the clearest association, had a very consistent clustering of results around the 60-100 kg/capita/year mark, regardless of GDP. The most notable change across the range of GDP per capita was the spread of results: whilst the averages stayed largely consistent, the upper extremes varied significantly. This can be viewed in Figure 5 in the main FWI report.

As a result, a model built from the correlation between these two figures was not considered appropriate and more general approach were considered. Example values are given for the Household sector.

Method 1: simple global mean (kg / capita / year) used for all countries, irrespective of whether they had data. This simplistic approach assumes that average global data will be more appropriate for a country, even if that country has a relevant study. As this assumption was known to be large, this approach was more to provide a check to other methods. (Household estimate using method 1 = 635 million tonnes.)

Method 2: This approach repeats Method 1 but derives a median average rather than a mean in order to quickly see the effect of outliers and their effect on the estimate. Like Method 1, this applies the average to all countries, including those which already have datapoints, which are replaced by the average. Again, this method was never intended as a serious 'contender' for use. (597 million tonnes).

Method 3: This approach uses a country's data where it is present. Where a country does not have data, it uses a global average (mean), as in Method 1. All countries are scaled by their 2019 population figures. For households, this provided a similar estimate to the method eventually used, illustrating the similarity in per capita food waste figures in countries of different income levels and regions. (560 million tonnes.)

Method 4: As for method 3, but using a median average for countries without their own data. For the household sector, as there were a few high values (potential outliers), this estimate is slightly lower than method 3. (551 million tonnes).

Method 5: As for method 3, but the mean average applied to countries without data is calculated from the dataset with high values (potential outliers) removed. For households, the threshold applied was 120 kg / capita / year, which removed data from six of the 52 countries with data. The resultant estimate was similar to method 4, and slightly lower than method 3 (544 million tonnes.)

Method 6: A forerunner to the method eventually adopted for household. For countries without data, a combination of global average, regional average and average from countries in the UN

classification of Developed or Developing were used[8]. These three averages were then combined in proportions depending on the number of data points that each average was calculated from.

The proportions were:

- The global average had a fixed weight of 0.33
- The regional average from the table below
- The Developed/Developing average makes up the rest of the weighting

Share of countries with estimate	Regional Average Confidence	Regional Confidence Weight
0	None	0
>0%	Low	0.33
33%	Medium	0.50
50%	High	0.67

For each country, the weighted averages are summed to generate an estimate. This is summarised below:

$$Food\ waste\ estimate = (Reg.Avg.\ *\ Reg.Weight) + (DvlpdDvlpngAvg * DvlpdDvlpngWeight) + (GlobalAvg * GlobalWeight\ (0.33))$$

This method gives a value of 567 million tonnes. This indicates the similarity of measured values of food waste between income groups and regions.

The value of food waste used for this report (569 million tonnes, method 7, Section 2.3.1) is very similar to method 6 (567 million tonnes). Given the similarity between the results of the seven different methods used for estimating a global average, the exact nature of the calculations has only a small impact on the results. Therefore, we have focused on a method that is likely to yield the most accurate results for each country (as presented in Section 2.3).

[8] Later analysis within this project suggested that the four groups of income level, as per the World Bank classification, were more appropriate. They provided more insight into the coverage of food waste data and amounts of food waste generated.

3 Appendix: Available estimates / datapoints used for level 1 modelling

This section contains tables with the datapoints used with the Level 1 modelling. This includes:

- The country and any other geographical boundaries of the study,
- A description of the method used in the study,
- The amount of food waste (normalised and, where necessary, adjusted for differences in scope or methodology)
- The study author and year to correspond with the bibliography
- The confidence in the estimate for the purposes of tracking food waste over time (see Section 2.3.3 for more details)

It is important to note that the confidence rating in this report is not a judgement on the quality of the study undertaken, it is an assessment – based on our understanding of the study – of how robust the estimate of food waste is for tracking food waste in the given country. In many cases, this was not an aim of the original study. Hence many good studies will be classified at a 'Medium' confidence level (or even excluded from consideration altogether) as the aims of the paper did not include national food waste tracking.

3.1 Available estimates / datapoints: Household

Table 10: Available datapoints for Household Sector, by country

Country	Subnational study area (if relevant)	Methodological Description	Adjusted kg/capita/year estimate	Source	Confidence Level
Australia		This paper represents the national baseline estimate for food waste commissioned by the Australian government in order to be the basis for measurement and reporting of progress on Australia's National Food Waste Strategy 2017. To generate the estimate for household, they combined state government data and modelling forward previously aggregated state government estimates which informed the National Waste Report (2016).	101.70	(Arcadis, 2019)	High Confidence
Austria		This presentation (in English) by the Environment Agency Austria references a range of other studies in German, summarising the current state of knowledge. These came from Waste Compositional Analyses, although precise details are not in the presentation (apart from for one region, Lower Austria). For the one paper where methodological aspects are given, it refers to sampling from three areas: rural (without centre); rural (with centre); urban, with 796 samples. Whilst more methodology on the other primary studies would have made this clearer, assuming similar methodologies are used in the other cases suggests a sufficiently large and diverse sample.	39.00	(Environment Agency Austria, 2017)	High Confidence
Bahrain		The source link is to a newspaper article which refers to a report by the Center for Waste Management. The original Center for Waste Management Report could not be found. However, the infographic (clearly copied from the original report) and the article make clear that a waste compositional analysis was undertaken, referring to 'huge quantities of household waste collected from the various region of Bahrain' being sorted. The inability to find the source paper means we cannot have high confidence in the results.	131.71	(Alayam, 2018)	Medium Confidence
Bangladesh	Chittagong	55 households in five different socioeconomic groups across three different areas had their waste sampled daily, using plastic bags provided to them. It was unclear for how long the sampling ran for each household. This small sample size and unknown duration means we cannot have high confidence.	73.63	(Salam et al., 2012)	Medium Confidence
	Chittagong	75 households across five socioeconomic groups in the Rahman Nagar Residential Area had their waste sampled. The length of sampling is unknown. The small sample with unknown duration means we cannot have high confidence in the results.	56.61	(Sujauddin et al., 2008)	Medium Confidence

Country	Subnational study area (if relevant)	Methodological Description	Adjusted kg/capita/year estimate	Source	Confidence Level
Belgium	Flanders	This paper combines a number of different data sources. An existing OVAM study was used for waste composition analysis in residual waste. This was combined with information from other surveys self-reporting different disposal methods to capture the share going to home compost, pets etc. and data from the Netherlands was used to inform the disposal to sink and toilet. The share which goes to feeding animals (28%) was removed as it is not considered waste, and the amount going to sinks/toilets (3%) was removed to improve comparability.	49.92	(Flemish Food Supply Chain Platform for Food Loss, 2017)	Medium Confidence
Belize	San Ignacio / Santa Elena	174 households across three socioeconomic groups had their waste sampled, with at least 100kg collected each sampling day. Measurement was for 8 days.	95.05	(Inter-American Development Bank, 2011)	Medium Confidence
	Caye Caulker	132 households across three socioeconomic groups had their waste sampled, with at least 100kg collected each sampling day. Measurement was for 8 days.	45.23		Medium Confidence
	San Pedro	169 households across three socioeconomic groups had their waste sampled, with at least 100kg collected each sampling day. Measurement was for 8 days.	36.20		Medium Confidence
	Belize City	183 households across three socioeconomic groups had their waste sampled, with at least 100kg collected each sampling day. Measurement was for 8 days.	34.21		Medium Confidence
Brazil		686 households participated in "a food diary with photo analysis of wasted food", with more households also participating in a questionnaire about consumption habits. As a diary result, it has been scaled to adjust for the measurement bias.	59.60	(Araujo et al., 2018)	Medium Confidence
Canada		56 different waste compositional analyses studies are analysed and averaged to form a national average. The studies analysed involved a mixture of kerbside analysis and at sorting facilities. The share which is food waste has been multiplied by the total residential waste to form a food waste estimate.	78.54	(Environment and Climate Change Canada, 2019)	High Confidence
China	Beijing	The paper references Zhang et al. (2010) but does not provide sufficient methodological detail to offer high confidence.	25.57	(Gao et al., 2013)	Medium Confidence
	Suzhou	140 households participated in a compositional analysis. This involved their waste being collected each day for a week and was repeated in each season. They also completed a survey. The household sizes are considered representative of the wider city.	67.31	(Gu et al., 2015)	Medium Confidence
	Shandong	207 houses across 21 villages in three prefectures (Jinan, Weifang, Dezhou) studied, tracked for 9 meals across 3 days. The weight of food recorded before cooking and after a meal's disposal to form 'meal waste' figure, but also measure 'non meal' waste (such as removal of mouldy stored items) once a day. It was a form of diary documenting this only looking at edible waste, so it is adjusted for both diary bias and the inedible share of waste.	21.20	(Li et al., 2021)	Medium Confidence
	Hong Kong	The paper cites the Hong Kong Environment Bureau's official statistics. It is assumed to be from Waste Compositional Analysis but is not made explicit, nor other details of the method (such as sample).	101.46	(Lo & Woon, 2016)	Medium Confidence
	Beijing	113 households across six districts in Beijing city had their waste collected and analysed daily for a period of 10 days.	58.98	(Qu et al., 2009)	Medium Confidence
		Paper quantifying the carbon, water and ecological footprints of food consumed and food wasted in Chinese households. Uses the China Health and Nutrition Survey (CHNS) 2011 database, with data from 12,850 households across 2004, 2006 and 2009 using a diary methodology over three days.	22.92	(Song et al., 2015)	Medium Confidence
	Urban China Total	The household estimate uses a huge range of local MSW figures and studies estimating the share of household food waste in the entire MSW. 196 samples obtained from the literature across 2001-2016. (Supplementary Info, Table S21-2). All literature values cited reported the value Household Food Waste in MSW, though it is unclear how exactly it was disaggregated if samples were taken at landfilling or transport sites. The per capita figure only applies to the urban population as this was where the study was concentrated.	150.00	(Zhang et al., 2020)	Medium Confidence
Colombia	Bogota	The paper cites 3259 samples, although it's unclear if this is referring to households or individuals, taken across a single twenty-four-hour period, across 19 localities and six socioeconomic categories. Whilst the length of sample is small, the size was considered to compensate for this.	70.43	(JICA, 2013)	Medium Confidence
Denmark		1474 households were randomly selected across five Danish municipalities in which there is no source segregation of household food waste. Depending on their collection schedule, their waste from one or two weeks was collected and sorted.	83.20	(Edjabou et al., 2016)	High Confidence

Country	Subnational study area (if relevant)	Methodological Description	Adjusted kg/capita/year estimate	Source	Confidence Level
		1600 houses sampled across four municipalities. It specifically looks at and disaggregates between single family homes and blocks of flats in each of those municipalities.	79.47	(Danish Environmental Protection Agency, 2018)	High Confidence
Estonia		100 households of various income levels and living arrangements took part in a diary study alongside a questionnaire survey. It has been adjusted to account for diary bias.	77.51	(Moora, Evelin, et al., 2015)	Medium Confidence
Ethiopia	Laga Tafo Laga Dadi town, Oromia	Bags distributed to 92 'residential households' for waste collection and sorting every day. From this waste compositional data, food waste can be derived. It is unclear for how long this compositional analysis took place. Survey in Laga Tafo Laga Dadi (sometimes written Legetafo Legedadi) town, Oromia, a small area on the outskirts of Addis Ababa. Note: different 'residential' groups are included in the paper, including 'real estate residential' and 'ropack village residential'. Due to some confusion over the terminology and these types having very high bone waste, only 'residential households' were considered here.	92.14	(Assefa, 2017)	Medium Confidence
Finland		References three different papers: from Katajajuuri et al. (2014), Silvenoinen et al. (2014) and HSY (2012). The Katajajuuri paper is also a separate data point in this database. The first two (diary studies) only estimate avoidable waste (120,000 tonnes), the latter (appears to be a waste compositional analysis) was used to estimate avoidable waste (230,000 tonnes). This was done to make them more comparable to other studies of all food waste. Since this adjusted total food waste estimate comes from Finland-specific data, it was judged that leaving it as a separate data point to compare and average with our generic edible and diary share adjusted figure would be prudent. The adjusted per capita figures are highly comparable to one another, giving some confidence in our estimate.	63.60	(Stenmarck et al., 2016)	Medium Confidence
		380 households participating in diary study for two weeks. Only looking at edible food. It is adjusted for diary bias and inedible share. The end result is highly comparable with the combined estimate cited in Stenmarck et al. (2016), which used Helsinki metropolitan area waste compositional data to adjust the original figure.	67.25	(Katajajuuri et al., 2014)	Medium Confidence
France		Paper in French, with summary available in English and details in Caldeira et al. (2019). 50 households in a representative sample of the French population were measured across 7 days using an online diary survey in which they documented waste each day and uploaded pictures. Only measuring edible food. This has been adjusted to account for both diary bias and the inedible waste share.	84.79	(ADEME, 2016)	Medium Confidence
Georgia	Kutaisi	Between 400-600kg of residual waste from residential areas taken and sorted. Done each month for a period of a year. Compositional information combined with MSW data to understand total waste. The paper does specify these samples came from residential areas, but they were collected from waste trucks rather than homes directly leading to some increased uncertainty.	100.97	(Denafas et al., 2014)	Medium Confidence
Germany		This is an English summary paper of a study in German, which means some of the details of the methodology are unclear. They claim to use "the best available data at the time of the study", which will include papers in German. Figure S.1 shows the admissible measurement methods and those which were applied for each sector, which is in line with the methods we are targeting here. However, the English summary does not include detail on the specific sources used so it is unclear how many of each method there are. For household they use Direct Measurement; Waste Composition Analysis; Records. This paper forms the 2015 baseline for food waste against which the national strategy for reducing food waste will be measured, it is therefore the preferred figure for Germany.	75.00	(Schmidt et al., 2019)	High Confidence
Ghana		1014 households representing 6083 people were randomly selected in 10 different districts across the country across three socioeconomic groups (low, medium, high). The households were provided with two bags, one for biodegradable waste and one for other waste, and were taught how to separate accordingly. Employed sorters then collected and did further sorting and disaggregation between every two days and twice a week for a period of five weeks, including sorting the biodegradable waste into a food subcategory. The per capita figure taken is the average across the socioeconomic groups provided in the paper.	84.01	(Miezah et al., 2015)	High Confidence

Country	Subnational study area (if relevant)	Methodological Description	Adjusted kg/capita/year estimate	Source	Confidence Level
Greece		252 households in urban and semi-urban areas of Athens, Heraklion and Chania were involved in a diary study, asked to weigh and record their waste (both avoidable and unavoidable) for a period of two weeks. This has been adjusted to account for diary bias.	141.69	(Abeliotis et al., 2015)	Medium Confidence
Hungary		165 households measured their waste in a diary for a week. This is a repeat of a 2016 study to identify changes in household waste. The definitions used are designed to be compliant with the EU FUSIONS project. It has been adjusted to account for diary bias.	93.83	(Kasza et al., 2020)	Medium Confidence
India	Dehradun	144 households across three different socioeconomic groups in Dehradun city were given a large bag in which to dispose their waste, which was then sorted and classified. It is unclear for how long the survey took place, so is assumed to have not met the '700 waste day' baseline and we therefore cannot have high confidence in the estimate.	72.99	(Grover & Singh, 2014)	Medium Confidence
	Rajam, Andhra Pradesh	25 households from 5 different segments of Rajam town were given two bags; one for wet and one for dry waste, collected each day. Segregated their waste for seven consecutive days, which was then taken for sorting.	57.84	(Ramakrishna, 2016)	Medium Confidence
	Dehradun	144 households from 11 major blocks of Dehradun city provided with waste bags in which to put their waste from a 24-hour period, which was then sorted and classified.	20.13	(Suthar & Singh, 2015)	Medium Confidence
Indonesia	Surabaya	100 households in Surabaya were provided with bags in which to put all of their daily waste for a period of 8 consecutive days. This was then collected and sorted, including into a separate food waste category.	77.37	(Dhokhikah et al., 2015)	Medium Confidence
Iraq	Baghdad	20 families in Baghdad, a mixture of family sizes and income levels, weighed their weekly purchases (this seems to have excluded meat) and kitchen waste on kitchen scales and documented them for a period of 8 months. This has been adjusted to account for diary bias. There is some uncertainty about the scope as the term kitchen waste and leftovers are used interchangeably: this could possibly be looking at edible waste only. Adjusting it as such would lead to an extreme food waste estimate, so this has been assumed not to be the case, but this uncertainty prevents us from having high confidence in the results.	75.07	(Al-Maliky & ElKhayat, 2012)	Medium Confidence
	Mosul	60 households, 10 from each sector of Mosul were given plastic bags and told to deposit their waste from a 24-hour period into it. It is unclear if this was repeated for individual houses or for how many days, though the paper does say that the study period was between February and July which would suggest it was repeated for households for some duration. A total of 1680 solid waste samples were collected.	84.66	(Al-Rawi & Al-Tayyar, 2013)	Medium Confidence
	Karbala	70 households in Karbala distributed plastic bags in which to put their waste from a 24-hour period. Done once a month for three months in winter and three months in summer.	141.61	(Al-Mas'udi & Al-Haydari, 2015)	Medium Confidence
	Al-Kut City	80 households across three income groups in Al-Kut had their waste collected daily for a period of one week, which was repeated one week per month for seven months. Whilst this is a large sample, there remains some uncertainty around definitions as to whether food or organic waste was measured, which could explain the quite substantial waste generation. As a result, we cannot have high confidence in the estimate.	137.53	(Sulaymon et al., 2010)	Medium Confidence
	Nassiriya	65 households representing 417 people across three income groups in Nassiriya were randomly selected. Distributed plastic bags in which to put waste which were collected daily and replaced over a period of seven months.	163.33	(Yasir & Abudi, 2009)	Medium Confidence
Ireland		Cited as being from the Irish Environmental Protection Agency (2015). The original source and weight estimates were not found based on the bibliography information or direct searches. However, it was judged by Stenmarck et al. (2016) to be 'data of sufficient quality'. The inability to find the source paper means we cannot have high confidence.	54.70	(Stenmarck et al., 2016)	Medium Confidence
Israel	Haifa	192 households across three neighbourhoods in Eastern Haifa, primarily middle-class households, provided with waste bags which were collected daily for the period of one week. Due to being a study within a specific unrepresentative area, we only have medium confidence.	94.18	(Elimelech et al., 2018)	Medium Confidence

Country	Subnational study area (if relevant)	Methodological Description	Adjusted kg/capita/year estimate	Source	Confidence Level
		The paper describes the figure as coming from "A comprehensive value chain model for various food production and consumption stages was designed to assess food waste and the potential for food rescue in Israel. The model is based on a bottom-up approach, and includes analysis of data relevant to agricultural production, import, export, industry, distribution and a sample of consumption patterns of 50 different types of food." [...] "For each type of food, the volume of input and output was measured in terms of gross agricultural product and loss rate for every stage of the value chain in the food production, distribution and consumption process." [...] "This data is indicative and intended to serve as the basis for public debate, and for further research and study". As a result, it is not that clear exactly the calculation that has taken place nor the original data sources, other than that they are 'bottom up'. Leket is a primary food rescue organisation in Israel and this paper was referred to us by contacts in the region. The lack of clarity on the methodological details means we cannot have high confidence in the estimate.	104.99	(Leket Israel, 2019)	Medium Confidence
Italy		388 families completed a food diary in which they recorded food disposed over the course of one week. The households were chosen by random stratified sampling and were considered representative in terms of region and household size. As a diary estimate, it has been adjusted to account for methodological bias.	67.05	(Giordano et al., 2019)	Medium Confidence
Japan		This presentation (in English) by the Food Industrial Policy Office presents statistics from the MAFF statistical survey, estimating waste from each of the sectors: Household (solid waste); Restaurant (assumed to mean all Food Service) and Retail. Wholesale estimated separately, not included. Estimates are for the 2014 financial year. The survey methodology is not presented. As a result of this methodological uncertainty, it is considered 'medium confidence' until more information is received.	64.32	(Food Industry Policy Office, 2017)	Medium Confidence
Kenya	Nairobi	150 households were sampled across five income groups (High, Middle, Low-Middle, Low, Slum), which are grouped in Table 2.2.7 into three residential groups (High, Middle, Low) with a subset of those sampled for composition. Total of 8 days collected but the first one was discounted as not representing daily generation, so 7 days of sample. A subset of this waste was then sorted and classified.	99.92	(JICA, 2010)	Medium Confidence
	Nairobi	90 households across three income areas (high, middle, low) received plastic bags for disposing daily waste. Total of 8 days collected but the first one was discounted as not representing daily generation, so 7 days of sample. This waste was then sorted and classified.	98.56	(Takeuchi, 2019)	Medium Confidence
Lebanon	Beirut	250 respondents completed a seven-day food waste diary in Beirut, alongside an attitudinal survey which a total of 500 people completed. Neighbourhoods were selected to be representative of the wider population, but the sampling of households within neighbourhoods was systematic random sampling. As a diary study, it has been adjusted for methodological bias.	104.66	(Chalak et al., 2019)	Medium Confidence
Luxembourg		This figure comes from a review paper which references a primary source (in German) which is mentioned as being a waste composition study, although further methodological details are not provided. This estimate has been complemented by a more recent study in the same country.	90.57	(Caldeira et al., 2019)	Medium Confidence
		Combination of waste statistics and a waste composition analysis undertaken in 2018-19, alongside other secondary and tertiary data. Further details are not known, but it is published by the Luxembourg Environment Administration.	88.50	(Luxembourg Environment Ministry, 2020)	Medium Confidence
Malaysia		Table 1 cites 'MHLG' (Ministry of Housing and Local Government) 2011, estimating food waste generation by source. This was not findable by the bibliography nor through a direct internet search. As a result, we cannot have high confidence in the estimate.	111.54	(Jereme et al., 2013)	Medium Confidence
	Bandar Baru Bangi	282 households were sampled across four neighbourhoods, which represent a mixture of different housing types (terraced housing, bungalows, flats). All in an area of Selangor described as a typical suburban area in the Kuala Lumpur area. Waste from a single day sampled in each area, sampling from the normal disposal routine rather than asking households to dispose of their waste differently. Panel 3 has breakdown of food into 'Unused food' (7.71% total household waste), 'General kitchen waste' (24.83% total household waste), 'big fruit peels' (10.32% total waste). Although this has a large sample, it is geographically restricted to one area so can only have medium confidence when used for the whole of Malaysia.	71.35	(Watanabe, 2012)	Medium Confidence

Country	Subnational study area (if relevant)	Methodological Description	Adjusted kg/capita/year estimate	Source	Confidence Level
Malta		The figure comes from a review paper which details the methodology of the original study. 700 households were randomly sampled for one week in each of July, October and April as part of a waste compositional analysis.	129.00	(Caldeira et al., 2019)	High Confidence
Mexico		This figure combines a number of sources, detailed in Appendix 5 of the report. Studies were identified in 3 states and 5 municipalities which directly measured the share of waste which was food waste at the household level. This is then scaled up using figures from the urban solid waste, which is primarily but not exclusively household waste: some small businesses and some larger ones (operating illegally) dispose of waste in the household municipal waste. The scale of non-household contamination is not known. As a result, it is no more than a medium confidence estimate for household food waste that likely slightly exaggerates its extent (in urban solid waste).	93.90	(Kemper et al., 2019)	Medium Confidence
Netherlands		The study combines multiple methods: 130 households across 13 municipalities had waste compositional analyses conducted, in order to determine solid waste; 1000 respondents to a consumer survey in order to determine waste destinations (i.e., how much was composted, fed to animals etc.); 1013 respondents to an app used to document liquid waste. This is the same methodology as was applied in a 2016 study. Avoidable and unavoidable waste were presented separately and have been summed. Liquid waste has not been included in our figure.	50.00	(The Netherlands Nutrition Centre Foundation, 2019)	High Confidence
New Zealand		597 households across six different local authorities had their waste audited. This only considers the kerbside domestic waste.	61.00	(Sunshine Yates Consulting, 2018)	High Confidence
Nigeria	Sapele	100 households covering a total of 334 people were selected by stratified random sampling, all in the Sapele area. Waste was collected from households after seven days and sorted.	188.80	(Orhorhoro et al., 2017)	Medium Confidence
Norway		210 households in the Fredrikstad and Hallingdal areas were randomly selected for waste sampling. These areas were considered to be sufficiently representative of the wider population for scaling purposes.	78.80	(Hanssen et al., 2016)	High Confidence
Pakistan	Gujranwala	60 urban households across three income groups (high middle and low). Provided with plastic bags which were collected daily for 8 days, though the first bag was disregarded for containing more than one day's waste. The sample was repeated across three seasons to account for variation. Rural households were considered within the study, these have been treated as a separate data point. As it is a study specific to a smaller geographic area, it is considered medium confidence for analysing the whole of Pakistan.	87.55	(JICA, 2015)	Medium Confidence
	Gujranwala	10 households in rural areas provided with plastic bags in which to deposit waste. Collected for 8 days but the first day was discounted due to covering more than a day's waste. The survey was repeated across three different seasons to account for variation. The small sample means we cannot have high confidence. Urban households were also studied but treated as a separate data point.	59.73		Medium Confidence
Poland	Surrounding Wroclaw	21 households, representing 83 people, were audited. None of them were involved in agricultural production. They were provided with three bags for sorting (bio-waste, hygienic waste, all other waste) and had waste collected in each of the four seasons. It is unclear for how long during each season the measurement took place. As a result of small sample size and unknown length, we cannot have high confidence in the estimate.	55.94	(Steinhoff-Wrześniewska, 2015)	Medium Confidence
Russian Federation		The paper cites what is assumed to be a waste composition analysis by the Higher School of Economics (which was not found when searched for) and data from Rosstat. In addition, the shares of waste at each stage are calculations based on data from Russian Agriculture Ministry (2017). The estimate provides a total food waste estimate as well as the amount of waste at each stage of the chain, these have been combined to form sector-specific estimates. The inability to trace the original source data and the lack of transparency on the calculations means we cannot have high confidence in this estimate.	33.38	(Tiarcenter, 2019)	Medium Confidence
Rwanda	Kigali	90 households surveyed in 3 districts. For each district, 10 households from each socioeconomic group (low, medium, high). Bags and scales were distributed to the households and they were told to separate food waste and other waste. The households weighed this each day for a period of two weeks, but regularly received visits from the researchers.	164.36	(Mucyo, 2013)	Medium Confidence

Country	Subnational study area (if relevant)	Methodological Description	Adjusted kg/capita/year estimate	Source	Confidence Level
Saudi Arabia		This study forms the Saudi waste Baseline, conducted by Saudi Grains Organisation (SAGO). 20,090 samples of domestic consumption were taken across 19 food products across 13 regions in Saudi Arabia. It is unclear, however, from how many households these samples arise. These were separated and weighed. This compositional analysis was supplemented by a behavioural study. The Household estimate is the share of waste attributed to 'Consumption'. Additional information and images to supplement the main study can be found here: https://www.macs-g20.org/fileadmin/macs/Activities/2020_FLW_WS/4_Session_3_FW_at_HH_level_small.pdf	104.88	(SAGO, 2019)	High Confidence
Slovenia		Data from the Slovenian Statistical Office, but the exact methodology is unclear. The methodological explanation from the same site mentions three different annual surveys on waste collection, generation and recovery/disposal, alongside an ad-hoc questionnaire of public waste collection services. It is unclear to whom the surveys are sent (i.e., to waste generators or to waste collection services) and if it requires submission of observed data or some other form of self-reporting.	32.83	(Republic of Slovenia Statistical Office, 2019)	Medium Confidence
		Data from the Slovenian Statistical Office, but the exact methodology is unclear. The methodological explanation from the same site mentions three different annual surveys on waste collection, generation and recovery/disposal, alongside an ad-hoc questionnaire of public waste collection services. It is unclear to whom the surveys are sent (i.e., to waste generators or to waste collection services) and if it requires submission of observed data or some other form of self-reporting.	35.58	(Republic of Slovenia Statistical Office, 2020)	Medium Confidence
South Africa	Richards Bay, Dundee and Harrismith	554 participants taking place in a face-to-face survey. They were asked to measure and record their waste for the 48hr before the survey. Survey across three towns of Richards Bay, Dundee and Harrismith. Mixture of urban, peri-urban and rural households.	17.69	(Chakona & Shackleton, 2017)	Medium Confidence
		This paper combines a literature review of waste compositional analyses disaggregated by income group across three cities (Cape Town, Johannesburg and Rustenburg). These are then scaled by the waste generation of those specific income groups nationally. Due to the comparison with other datapoints from South Africa and their large variation, this was not considered an estimate in which we could have high confidence.	27.33	(Nahman et al., 2012)	Medium Confidence
	Johannesburg	44,927 households across 74 collection routes in Johannesburg were sampled during a 6-week period, with random grab sub-samples from municipal waste collection trucks in residential areas, which were then analysed for composition. The result is particularly low which is notable when compared to other studies in nearby countries. This could suggest that some other waste (such as from small businesses, or illegal dumping) is being collected as part of the household waste stream.	12.00	(Oelofse et al., 2018)	Medium Confidence
	Ekurhuleni	20,439 households across 41 collection routes in Ekurhuleni were sampled during a 6-week period, with random grab sub-samples from municipal waste collection trucks in residential areas, which were then analysed for composition. The result is particularly low which is notable when compared to other studies in nearby countries. This could suggest that some other waste (such as from small businesses, or illegal dumping) is being collected as part of the household waste stream.	8.00		Medium Confidence
	Tshwane Metropolitan Municipality	123 households across 5 areas of Tshwane Metropolitan Municipality had their food waste weighed. The food waste was collected separately and weighed on a weekly basis for a period of 3 weeks. The sample of 123 are out of 133 respondents on a survey who indicated that they wasted food. Another 77 respondents indicated that they did not waste food, and were seemingly not asked to weigh their waste. This may bias the results by only auditing those who self-describe themselves as someone who wastes food, and not including measurements from much smaller waste generators. The paper does not present a single waste figure. Instead, it has been derived from Table 4.9 using the waste generation rate per household, number of people in household and share of that household size in the sample to get a weighted per capita estimate (the Sum of [household waste / number of people in household] * [share of total sample which is this household size] for each household size). The paper does include some disposal method information but not enough to adjust the figures. For example, 14% of respondents claimed they fed food waste to pets, but this does not clearly translate to 14% of food waste being fed to animals. As a result, no adjustment was carried out.	133.85	(Ramukhwatho, 2016)	Medium Confidence

Country	Subnational study area (if relevant)	Methodological Description	Adjusted kg/capita/year estimate	Source	Confidence Level
Spain		The figure comes from a review paper which cites a study produced by the Spanish Environment Ministry. It involved 4000 households doing an online waste diary survey, 2000 of which documented their shopping and waste with the other half used to develop user profile and preferences. This only looks at edible waste so has been adjusted.	77.65	(Caldeira et al., 2019)	Medium Confidence
		The figure comes from a review paper which cites a study produced by the Spanish Environment Ministry. It is similar to the other Spanish datapoint but involves a higher number of households, with 12,000 considered for building the profile of shopping habits and 4,000 doing the waste diary. This only looks at edible waste so has been adjusted.	77.00		Medium Confidence
Sri Lanka	Jaffna	The JICA study refers to a range of locally conducted surveys on waste generation units and waste composition, combined with waste generation rates obtained by SATREPS (Science and Technology Research Partnership for Sustainable Development) in 2014, a previous JICA project. The methodological details of the locally outsourced surveys are not clear. Although the waste generation rates are captured at a household level, it appears as though the compositional analysis may have been done at an aggregated level, such as at the landfill. This and the methodological uncertainty reduce our confidence in the estimates, so they are rated 'medium confidence' only.	118.28	(JICA, 2016)	Medium Confidence
	Nuwara Eliya	The JICA study refers to a range of locally conducted surveys on waste generation units and waste composition, combined with waste generation rates obtained by SATREPS (Science and Technology Research Partnership for Sustainable Development) in 2014, a previous JICA project. The methodological details of the locally outsourced surveys are not clear. Although the waste generation rates are captured at a household level, it appears as though the compositional analysis may have been done at an aggregated level, such as at the landfill. This and the methodological uncertainty reduce our confidence in the estimates, so they are rated 'medium confidence' only.	95.37		Medium Confidence
	Kataragama	The JICA study refers to a range of locally conducted surveys on waste generation units and waste composition, combined with waste generation rates obtained by SATREPS (Science and Technology Research Partnership for Sustainable Development) in 2014, a previous JICA project. The methodological details of the locally outsourced surveys are not clear. Although the waste generation rates are captured at a household level, it appears as though the compositional analysis may have been done at an aggregated level, such as at the landfill. This and the methodological uncertainty reduce our confidence in the estimates, so they are rated 'medium confidence' only.	94.79		Medium Confidence
	Thamankaduwa	The JICA study refers to a range of locally conducted surveys on waste generation units and waste composition, combined with waste generation rates obtained by SATREPS (Science and Technology Research Partnership for Sustainable Development) in 2014, a previous JICA project. The methodological details of the locally outsourced surveys are not clear. Although the waste generation rates are captured at a household level, it appears as though the compositional analysis may have been done at an aggregated level, such as at the landfill. This and the methodological uncertainty reduce our confidence in the estimates, so they are rated 'medium confidence' only.	79.31		Medium Confidence
	Katunayake	The JICA study refers to a range of locally conducted surveys on waste generation units and waste composition, combined with waste generation rates obtained by SATREPS (Science and Technology Research Partnership for Sustainable Development) in 2014, a previous JICA project. The methodological details of the locally outsourced surveys are not clear. Although the waste generation rates are captured at a household level, it appears as though the compositional analysis may have been done at an aggregated level, such as at the landfill. This and the methodological uncertainty reduce our confidence in the estimates, so they are rated 'medium confidence' only.	78.47		Medium Confidence
	Moratuwa	The JICA study refers to a range of locally conducted surveys on waste generation units and waste composition, combined with waste generation rates obtained by SATREPS (Science and Technology Research Partnership for Sustainable Development) in 2014, a previous JICA project. The methodological details of the locally outsourced surveys are not clear. Although the waste generation rates are captured at a household level, it appears as though the compositional analysis may have been done at an aggregated level, such as at the landfill. This and the methodological uncertainty reduce our confidence in the estimates, so they are rated 'medium confidence' only.	74.78		Medium Confidence

Country	Subnational study area (if relevant)	Methodological Description	Adjusted kg/capita/year estimate	Source	Confidence Level
	Kesbewa	The JICA study refers to a range of locally conducted surveys on waste generation units and waste composition, combined with waste generation rates obtained by SATREPS (Science and Technology Research Partnership for Sustainable Development) in 2014, a previous JICA project. The methodological details of the locally outsourced surveys are not clear. Although the waste generation rates are captured at a household level, it appears as though the compositional analysis may have been done at an aggregated level, such as at the landfill. This and the methodological uncertainty reduce our confidence in the estimates, so they are rated 'medium confidence' only.	74.78		Medium Confidence
	Dehiwala Mt Lavinia	The JICA study refers to a range of locally conducted surveys on waste generation units and waste composition, combined with waste generation rates obtained by SATREPS (Science and Technology Research Partnership for Sustainable Development) in 2014, a previous JICA project. The methodological details of the locally outsourced surveys are not clear. Although the waste generation rates are captured at a household level, it appears as though the compositional analysis may have been done at an aggregated level, such as at the landfill. This and the methodological uncertainty reduce our confidence in the estimates, so they are rated 'medium confidence' only.	74.78		Medium Confidence
	Kurunegala	The JICA study refers to a range of locally conducted surveys on waste generation units and waste composition, combined with waste generation rates obtained by SATREPS (Science and Technology Research Partnership for Sustainable Development) in 2014, a previous JICA project. The methodological details of the locally outsourced surveys are not clear. Although the waste generation rates are captured at a household level, it appears as though the compositional analysis may have been done at an aggregated level, such as at the landfill. This and the methodological uncertainty reduce our confidence in the estimates, so they are rated 'medium confidence' only.	47.48		Medium Confidence
	Trincomalee	The JICA study refers to a range of locally conducted surveys on waste generation units and waste composition, combined with waste generation rates obtained by SATREPS (Science and Technology Research Partnership for Sustainable Development) in 2014, a previous JICA project. The methodological details of the locally outsourced surveys are not clear. Although the waste generation rates are captured at a household level, it appears as though the compositional analysis may have been done at an aggregated level, such as at the landfill. This and the methodological uncertainty reduce our confidence in the estimates, so they are rated 'medium confidence' only.	20.60		Medium Confidence
Sweden		The estimate comes from Avfall Sverige (Swedish Waste management and Recycling Association) data on the amounts of separate food waste collection and composition estimates for mixed municipal waste. Home composting is included in the separate food waste estimate. The waste estimates are adjusted by a figure of 0.80 to account for home-like business waste collected by municipalities.	81.00	(Swedish Environmental Protection Agency, 2014)	High Confidence
United Kingdom of Great Britain and Northern Ireland		Household data comes from a combination of data on the composition and weight of residual and organic recycling schemes from Local Authorities. The share of waste which is disposed of via the sewer has been removed from the estimate, though the waste composted at home has not.	77.00	(WRAP, 2020)	High Confidence
United Republic of Tanzania	Kinondoni municipality, Dar es Salaam	75 households in middle and low-income settlements, primarily in high population density informal settlements. Provided with waste bags for three different days which were collected and sorted.	119.09	(Oberlin, 2013)	Medium Confidence
United States of America		US EPA synthesis of food waste consistent with the FLW protocol. Combines waste generation factors from other studies with relevant scaling statistics. 12 studies which directly measure waste were used to inform residential generation rate, nearly all of which were waste compositional analyses. 15% going to sewer / wastewater treatment has been removed.	58.83	(U.S. Environmental Protection Agency, 2020)	High Confidence
Viet Nam	Mekong Delta	100 households across ten different sampling points were selected. The sample is considered to be representative of Can Tho City in terms of household size. They had their waste analysed at two points in time: once in the dry season for a month, once in the rainy season for a two-week period.	85.38	(Thanh et al., 2010)	Medium Confidence

Country	Subnational study area (if relevant)	Methodological Description	Adjusted kg/capita/year estimate	Source	Confidence Level
	Da Nang	120 households were sampled for the period of one week. They were provided with plastic bags in which to put household waste which were collected daily. Satellite imagery on the distribution of housing types in Da Nang were used to scale the data according to those housing types and form an estimate for the city.	66.94	(Vetter-Gindele et al., 2019)	Medium Confidence
Zambia	Ndola	60 households across three areas (distinguished by housing density) sorted their waste weekly for a period of one month. The households were given plastic containers for different wastes: food, plastics, paper, textile, grass and other wastes. They therefore separated it themselves but did not weigh or estimate it themselves.	77.92	(Edema et al., 2012)	Medium Confidence

3.2 Available estimates / datapoints: Food Service

Table 11: Available datapoints for Food Service, by country

Identified food service food waste data					
Country	**Subnational study area (if relevant)**	**Methodological Description**	**Adjusted kg/capita/year estimate**	**Source (study number)**	**Confidence Level**
Australia		This paper represents the national baseline estimate for food waste commissioned by the Australian government in order to be the basis for measurement and reporting of progress on Australia's National Food Waste Strategy 2017. The figure was calculated through a number of surveys and published figures for hospitality and food service (commercial), and a range of small samples at institutions such as hospitals and universities. These were scaled based on relevant figures such as the number of students and inmates for schools and prisons respectively. The authors highlight low confidence in the institutional estimates due to small samples. However, it represents wide coverage and the low confidence is "not considered material given the estimated scale of food waste produced".	21.68	(Arcadis, 2019)	High Confidence
Austria		50 establishments had waste compositional analyses carried out (23 canteen kitchens, including hospitals and nursing homes; 13 accommodation establishments; 13 restaurants, 1 catering). This represents wide coverage of both commercial and non-commercial out of home consumption. From the compositional analyses, extrapolation was based on food waste quantities per meals, number of meals per establishment type and number of establishment types.	25.68	(Environment Agency Austria, 2017)	High Confidence
		The original paper referenced is in German. The reference explains that 29 hospitality companies including restaurants, hotels and canteen kitchens recorded their food waste. This therefore has coverage across both commercial and non-commercial dining.	31.09	(Caldeira et al., 2019)	High Confidence
Bangladesh	Dhaka	The JICA study team conducted waste generation source surveys in both the dry and wet season. The exact number of restaurants is not known, only that 50 non-households were sampled across 8 days in each season (this figure will include other buildings, such as shops or offices). It was scaled to the whole of Dhaka based on the Revenue Department's licensing list. Being incomplete in its sectoral coverage and being quite a dated estimate limit its robustness. Note: the JICA paper does also estimate the waste for hotels, which would be considered here, however the table defining the share of food waste from hotels groups it with shops, which would otherwise be considered retail. To avoid this overlap they have not been documented.	3.34	(JICA, 2005)	Medium Confidence

Belgium	Flanders	The data comes from a range of sources, many of which are commercial and therefore not transparently disclosed. The authors collaborated with food chain partners (horeca Vlaanderen and Unie Belgische Catering) and used existing surveys including Annual Foodservice Monitor and the Integrated Environmental Report. These sources allowed a per person daily waste to be derived, which was then scaled. It covers both hospitality (commercial) and catering (non-commercial). Hospitality and catering are presented separately in the paper, they are summed together here. Their figures have been scaled for the whole of Belgium, assuming that Flanders can be considered representative of the whole nation.	19.70	(Flemish Food Supply Chain Platform for Food Loss, 2017)	Medium Confidence
China	East China	This paper aggregates a huge number of what they term 'catering waste' papers. 47 of them in total from various areas of China. It's a mixture of surveys, official statistics, author's calculations etc. to create data on catering food waste across different regions. This is then associated to a number of correlates which are used to predict growing food waste in future. The authors worked with datapoints from a range of years and other data to form a 2019 estimate which is what we use here.	51.87	(Zhang et al., 2020)	High Confidence
	Middle China	This paper aggregates a huge number of what they term 'catering waste' papers. 47 of them in total from various areas of China. It's a mixture of surveys, official statistics, author's calculations etc. to create data on catering food waste across different regions. This is then associated to a number of correlates which are used to predict growing food waste in future. The authors worked with datapoints from a range of years and other data to form a 2019 estimate which is what we use here.	49.31		High Confidence
	West China	This paper aggregates a huge number of what they term 'catering waste' papers. 47 of them in total from various areas of China. It's a mixture of surveys, official statistics, author's calculations etc. to create data on catering food waste across different regions. This is then associated to a number of correlates which are used to predict growing food waste in future. The authors worked with datapoints from a range of years and other data to form a 2019 estimate which is what we use here.	47.48		High Confidence
	Urban China Total	This paper aggregates a huge number of what they term 'catering waste' papers. 47 of them in total from various areas of China. It's a mixture of surveys, official statistics, author's calculations etc. to create data on catering food waste across different regions. This is then associated to a number of correlates which are used to predict growing food waste in future. The authors worked with datapoints from a range of years and other data to form a 2019 estimate which is what we use here. The total waste figure itself was not listed in the text but was confirmed with the authors as being 38 million tonnes. This refers only to urban catering waste.	45.00		High Confidence

	Northeast China	This paper aggregates a huge number of what they term 'catering waste' papers. 47 of them in total from various areas of China. It is a mixture of surveys, official statistics, author's calculations etc. to create data on catering food waste across different regions. This is then associated to a number of correlates which are used to predict growing food waste in future. The authors worked with datapoints from a range of years and other data to form a 2019 estimate which is what we use here.	34.33		High Confidence
Denmark		Electronic questionnaire studies were issues to chefs among hotels, restaurants and canteens. 474 chefs reported information about their food waste. The paper also refers to 53 businesses being studied; it is unclear if this number includes out of home consumption businesses or just retail. The authors claim it was designed to be as representative as possible. The figure taken is the sum of Hotels (4), Restaurants (5), Institutions (6) and Canteens (7). Confidence intervals of ±25 are provided for hotels and restaurants, ±50 for institutions and ±10 for canteens.	20.64	(Danish Environmental Protection Agency, 2014)	High Confidence
Estonia		20 catering institutions had waste audits run: 3 restaurants, 3 bars/pubs, 3 cafes, 4 canteens/buffets, 3 schools, 3 kindergartens, 1 hospital. This therefore offers a good variation of commercial and non-commercial out of home consumption. Across 5 days, waste was measured at preparation, serving, consumption and storing food to provide waste generation figures which was scaled up.	16.61	(Moora, Evelin, et al., 2015)	High Confidence
Finland		References three different papers: from Katajajuuri et al. (2014), Silvenoinen et al. (2014) and HSY (2012). The Katajajuuri paper is also a separate data point in this database. The first two only estimate avoidable waste (80,000 tonnes), the latter was used to estimate avoidable waste (50,000 tonnes). This was done to make them more comparable to other studies of all food waste. Since this adjusted total food waste estimates comes from Finland-specific data, it was judged that leaving it as a separate data point to compare and average with our generic edible share adjusted figure would be prudent. The adjusted per capita figures are highly comparable to one another, giving some confidence in our estimate.	24.04	(Stenmarck et al., 2016)	Medium Confidence
		This paper includes the results of two separate studies, one on the commercial sector and one on the non-commercial sector. The commercial sector study involved 72 restaurants across 17 businesses - a range of diners, cafes, restaurants, hotels etc. - having their waste measured for a single day. The non-commercial study involved 55 outlets representing three companies providing food for day care, hospitals and workplace canteens, measured over one week. Table 5 in the paper refers to "avoidable food waste in the Finnish food supply chain" suggesting that this did not measure total food waste, only the avoidable share, and the figure is therefore adjusted to estimate this inedible or unavoidable share.	22.57	(Katajajuuri et al., 2014)	Medium Confidence

France		Combination of studies across canteens and restaurants. 22 canteens and 37 restaurants interviewed. Most of these were self-estimation without measurement, though some measurements were taken independent of the study. The study also conducted a waste audit in one canteen and one restaurant. These were compared to a similar 2011 Agriculture Ministry study of out of home waste. They used this information to confirm the underestimation of out of home actors to their own waste and prioritise the 'realised' measure over the actor estimate. The waste per meal (including storage waste from kitchen, not just plate waste) is scaled for the respective commercial and non-commercial sector. However, it only looks at edible waste (destined for human consumption) and no preparation waste. This is therefore adjusted.	31.60	(ADEME, 2016)	Medium Confidence
		Estimate judged to be of 'sufficient quality' by Stenmarck et al. (2016), it combines literature references from a Danish Environmental Ministry Report (2010) and ADEME (2004).	17.37	(BIO Intelligence Service, 2010)	Medium Confidence
Germany		This is an English summary paper of a study in German, which means some of the details of the methodology are unclear. They claim to use "the best available data at the time of the study", which will include papers in German. Figure S.1 shows the admissible measurement methods and those which were applied for each sector, which is in line with the methods we are targeting here. However, the English summary does not include detail on the specific sources used so it is unclear how many of each method there are. For out of home, they use Direct Measurements; Waste Composition Analysis; Records. This paper forms the 2015 baseline for food waste against which the national strategy for reducing food waste will be measured, it is therefore the preferred figure for Germany.	20.58	(Schmidt et al., 2019)	High Confidence
Ireland		Cited as being from the Irish Environmental Protection Agency (2015). The original source and weight estimates were not found based on the bibliography information or direct searches. However, it was judged by Stenmarck et al. (2016) to be 'data of sufficient quality'. The inability to find the source paper means we cannot have high confidence.	56.15	(Stenmarck et al., 2016)	Medium Confidence

Israel		The paper describes the figure as coming from "A comprehensive value chain model for various food production and consumption stages was designed to assess food waste and the potential for food rescue in Israel. The model is based on a bottom-up approach, and includes analysis of data relevant to agricultural production, import, export, industry, distribution and a sample of consumption patterns of 50 different types of food." [...] "For each type of food, the volume of input and output was measured in terms of gross agricultural product and loss rate for every stage of the value chain in the food production, distribution and consumption process." [...] "This data is indicative and intended to serve as the basis for public debate, and for further research and study". As a result, it is not that clear exactly the calculation that has taken place nor the original data sources, other than that they are 'bottom up'. Leket is a primary food rescue organisation in Israel and this paper was referred to us by contacts in the region. The lack of clarity on the methodological details means we cannot have high confidence in the estimate.	27.44	(Leket Israel, 2019)	Medium Confidence
Japan		This presentation (in English) by the Food Industrial Policy Office presents statistics from the MAFF statistical survey, estimating waste from each of the sectors: Household (solid waste); Restaurant (assumed to mean all Food Service) and Retail. Wholesale estimated separately, not included. Estimates are for the 2014 financial year. The survey methodology is not presented. As a result of this methodological uncertainty, it is considered 'medium confidence' until more information is received. For Retail and Food Service, the figures have been adjusted to account for the share going to animal feed, also included in the presentation.	14.75	(Food Industry Policy Office, 2017)	Medium Confidence
Kenya	Nairobi	Across retail and out of home consumption, 90 locations had their waste analysed for a period of seven days, which was preceded by a one-day test measurement, which was excluded from analysis. The figure presented is the sum of Restaurants, Hotels and Public Facilities, each of which had a distinct waste generation rate and food waste generation share. The original study scales this by the number of institutions in Nairobi.	31.14	(JICA, 2010)	Medium Confidence
Luxembourg		Combination of waste statistics and interviews and surveys with enterprises. Further details are not known, but it is published by the Luxembourg Environment Administration.	20.90	(Luxembourg Environment Ministry, 2020)	Medium Confidence
Malaysia		Table 1 cites 'MHLG' (Ministry of Housing and Local Government) 2011, estimating food waste generation by source. This was not findable by the bibliography nor through a direct internet search. As a result, we cannot have high confidence in the estimate.	89.56	(Jereme et al., 2013)	Medium Confidence

Norway		References the research project KuttMatsvinn2020, which focused on hotels, convenience stores and employee cafeterias, sampling around 2000 catering outlets. Work on other subsectors such as schools and restaurants is underway; as a result it appears as though the estimate has not accounted for these other sectors, making it an incomplete Food Service estimate. Uses the ForMat definition of food which only measures edible food waste, not inedible parts. It has therefore been adjusted to increase comparability. In this definition, food sent to animal feed is considered waste. It was not possible to adjust and account for this as the share of food going to animal feed was only included for the production stage; it is therefore assumed no food waste is going to animals at other stages.	4.96	(Stensgård et al., 2019)	Medium Confidence
Serbia		Interviews conducted with approximately 100 hotels, restaurants and caterers to determine the share of food waste at the stages of kitchen preparation and plate waste. Unclear to what extent survey respondents were estimating or based on internal measurement. The waste generation factors from this were applied to CEVES estimates on food purchases in Serbian HoReCa.	6.00	(Bogdanović, et al., 2019)	Medium Confidence
Slovenia		Data from the Slovenian Statistical Office, but the exact methodology is unclear. The methodological explanation from the same site mentions three different annual surveys on waste collection, generation and recovery/disposal, alongside an ad-hoc questionnaire of public waste collection services. It is unclear to whom the surveys are sent (i.e., to waste generators or to waste collection services) and if it requires submission of observed data or some other form of self-reporting.	19.54	(Republic of Slovenia Statistical Office, 2019)	Medium Confidence
		Data from the Slovenian Statistical Office, but the exact methodology is unclear. The methodological explanation from the same site mentions three different annual surveys on waste collection, generation and recovery/disposal, alongside an ad-hoc questionnaire of public waste collection services. It is unclear to whom the surveys are sent (i.e., to waste generators or to waste collection services) and if it requires submission of observed data or some other form of self-reporting.	20.25	(Republic of Slovenia Statistical Office, 2020)	Medium Confidence
Sweden		This estimate takes waste factors derived from two different papers, both in Swedish. One is a restaurant-specific factor taken from Jensen et al. (2011) which was then scaled by waste per employee. The other is a catering factor from Stare et al. (2013), which has a factor of waste per portion in schools. This has been applied to schools and other catering facilities, including prisons and healthcare.	21.00	(Swedish Environmental Protection Agency, 2014)	High Confidence
		This estimate takes waste factors derived from two different papers, in Swedish. One is a restaurant-specific factor taken from Jensen et al. (2011) which was then scaled by waste per employee. The other is a catering factor from Stare et al. (2013), which has a factor of waste per portion in schools. This has been applied to schools and other catering facilities, including prisons and healthcare.	20.00		High Confidence
Switzerland		This paper cites Baier and Reinhard (2007) for food service installations, and Andrini and Bauen (2005) for restaurants. Both are in German and involved waste audits. 40 food service installations were audited and 20 restaurants. These estimates have been combined to create an estimate of total Out of Home waste.	40.00	(Beretta et al., 2013)	Medium Confidence

United Kingdom of Great Britain and Northern Ireland		Food waste data remodelled based on WRAP's 2013 analysis of food waste in the hospitality and food service sector, a study which employed waste compositional analyses and analysis of DEFRA survey information. This data was re-weighted to account for the change in number and size of premises, number of pupils served by school catering etc.	16.50	(WRAP, 2020)	High Confidence
United States of America		US EPA synthesis of food waste consistent with the FLW protocol. Combines waste generation factors from other studies with relevant scaling statistics, such as employees or revenue for a sector. Food Service as an estimate which combines hospitality (hotels, restaurants/food service; sports venues) and institutional (healthcare, office buildings, military and prisons, schools and universities). 51 studies in total used to inform Food Service generation rate across the various subsectors. Waste management pathways were provided for the commercial and institutional subsectors separately; only in the commercial hospitality subsector was some surplus managed to a non-waste destination (14% donated), this has been accounted for.	63.62	(U.S. Environmental Protection Agency, 2020)	High Confidence

3.3 Available estimates / datapoints: Retail

Table 12: Available datapoints for Manufacturing, by country

Country	Subnational study area (if relevant)	Methodological Description	Adjusted kg/capita/year estimate	Source (study number)	Confidence Level
Australia		This paper represents the national baseline estimate for food waste commissioned by the Australian government in order to be the basis for measurement and reporting of progress on Australia's National Food Waste Strategy 2017. The Retail figure was calculated through publicly available waste estimates for major supermarkets and data from large shopping centre organisations. The source paper also has an estimate for Wholesale, which has been excluded here.	9.45	(Arcadis, 2019)	High Confidence
Austria		Five different retail companies, with market share of about 83%, contributed data on their food waste. This paper was also referenced by EU FUSIONS and judged to be 'data of sufficient quality'.	8.63	(Environment Agency Austria, 2017)	High Confidence
Belgium	Flanders	A combination of data from the Integrated Environmental Report and sector surveys by COMEOS and Buurtsuper.be. Where these were national surveys, the authors adjusted to Flanders based on sales figures. Their figures have been scaled for the whole of Belgium, assuming that Flanders can be considered representative of the whole nation. 3% of this sector is estimated to go to animal feed, which is not considered waste. The numbers have been adjusted to reflect this.	9.71	(Flemish Food Supply Chain Platform for Food Loss, 2017)	Medium Confidence

Denmark		Paper is in Danish but has a summary in English. The waste from 53 businesses was studied, 69 were visited to discuss their food waste management. It's unclear what share of this sample was retail, but the paper claims the sample was aimed to be representative. It analyses not just non-specialised stores (supermarkets etc.) but also specialised stores such as butchers, fishmongers and greengrocers. The value is the sum of non-specialised (1) and specialised retail (2) but does not include wholesale (3). Confidence intervals of ±25 are given for each retail sector.	29.80	(Danish Environmental Protection Agency, 2014)	High Confidence
Estonia		This study cites a paper in Estonian from which the figures are taken. 11 retailers had detailed analyses carried out including interviews, on-site observations and weighing. An additional questionnaire was sent to 600 retailers and 183 wholesalers, scaled by grocery store distribution across Estonia. This study was also cited in Stenmarck et al. (2016) with a slightly different waste figure, it is unclear if this is rounding error or some other calculation.	4.70	(Caldeira et al., 2019)	Medium Confidence
		Study in Estonian, referenced in Stenmarck et al. (2016), which details that 11 retailers had detailed analyses carried out including interviews, on-site observations and weighing. An additional questionnaire was sent to 600 retailers and 183 wholesalers, scaled by grocery store distribution across Estonia. This paper is also referenced in Caldeira et al. (2019) with a slightly different waste figure, it is unclear why these are different.	4.72	(Moora, Piirsalu, et al., 2015)	Medium Confidence
France		Paper in French, with summary available in English and details in Caldeira et al. (2019). Across the supply chain, 582 interviews took place: 512 'quali-quantitative', 80 qualitative. Looks only at edible waste (food for human consumption), so has been adjusted.	25.60	(ADEME, 2016)	Medium Confidence
Germany		This is an English summary paper of a study in German, which means some of the details of the methodology are unclear. They claim to use "the best available data at the time of the study", which will include papers in German. Figure S.1 shows the admissible measurement methods and those which were applied for each sector, which is in line with the methods we are targeting here. However, the English summary does not include detail on the specific sources used so it's unclear how many of each method there are. For 'trade', which we are understanding as retail, they use Direct Measurements and Counts and Scans. There is a risk that wholesale has been included in this figure. This paper forms the 2015 baseline for food waste against which the national strategy for reducing food waste will be measured, it is therefore the preferred figure for Germany.	5.97	(Schmidt et al., 2019)	High Confidence
Greece		Paper cites 'Greek Waste Statistics' from 2011 which could not be found based on the bibliography reference or internet searches. However, it was judged to be 'data of sufficient quality' by Stenmarck et al. (2016). The inability to find the source paper means we cannot have high confidence.	7.38	(Stenmarck et al., 2016)	Medium Confidence
Israel		The paper describes the figure as coming from "A comprehensive value chain model for various food production and consumption stages was designed to assess food waste and the potential for food rescue in Israel. The model is based on a bottom-up approach, and includes analysis of data relevant to agricultural production, import, export, industry, distribution and a sample of consumption patterns of 50 different types of food." [...] "For each type of food, the volume of input and output was measured in terms of gross agricultural product and loss rate for every stage of the value chain in the food production, distribution and consumption process." [...] "This data is indicative and intended to serve as the basis for public debate, and for further research and study". As a result, it is not that clear exactly the calculation that has taken place nor the original data sources, other than that they are 'bottom up'. Leket is a primary food rescue organisation in Israel and this paper was referred to us by contacts in the region. The lack of clarity on the methodological details means we cannot have high confidence in the estimate.	51.41	(Leket Israel, 2019)	Medium Confidence
Italy		17 retail stores, including both supermarkets and hypermarkets had their waste weighed. The linked infographic suggests a combination of direct weighing and item scanning, which was used to form a waste generation factor by retail space, which was then scaled up nationwide.	3.63	(Clara Cicatiello et al., 2019)	High Confidence

Japan		This presentation (in English) by the Food Industrial Policy Office presents statistics from the MAFF statistical survey, estimating waste from each of the sectors: Household (solid waste); Restaurant (assumed to mean all Food Service) and Retail. Wholesale estimated separately, not included. Estimates are for the 2014 financial year. The survey methodology is not presented. As a result of this methodological uncertainty, it is considered 'medium confidence' until more information is received. For Retail and Food Service, the figures have been adjusted to account for the share going to animal feed, also included in the presentation.	8.63	(Food Industry Policy Office, 2017)	Medium Confidence
Kenya	Nairobi	Across retail and out of home consumption, 90 locations had their waste analysed for a period of seven days, which was preceded by a one-day test measurement, which was excluded from analysis. Figure is a sum of Shop and Market, which are measured separately. The original study scales this by the number of institutions in Nairobi.	10.96	(JICA, 2010)	Medium Confidence
Luxembourg		This figure comes from a review paper which references a primary source (in German) which is mentioned as being a survey to retail and distribution companies, although further methodological details are not provided. This estimate has been complemented by a more recent study in the same country.	9.10	(Caldeira et al., 2019)	Medium Confidence
		The paper cites 'Luxembourg Waste Statistics 2015'. This was not found either through the bibliography or through a direct internet search. However, it was considered 'data of sufficient quality' for the purposes of EU FUSIONS. The inability to find the source paper means we cannot have high confidence.	3.90	(Stenmarck et al., 2016)	Medium Confidence
		Combination of waste statistics and interviews and surveys with enterprises. Further details are not known, but it is published by the Luxembourg Environment Administration.	8.70	(Luxembourg Environment Ministry, 2020)	Medium Confidence
Malaysia		Table 1 cites 'MHLG' (Ministry of Housing and Local Government) 2011, estimating food waste generation by source. This was not findable by the bibliography nor through a direct internet search. As a result, we cannot have high confidence in the estimate.	78.82	(Jereme et al., 2013)	Medium Confidence
Netherlands		The document cites a paper (De Waart, 2011) which could not be found through a direct internet search for the paper. As a result, it cannot be verified any further. It was judged to be data of 'sufficient quality' for the EU FUSIONS project, however. The inability to find the source paper means we cannot have high confidence.	11.00	(Stenmarck et al., 2016)	Medium Confidence
New Zealand		This summary document refers to a University of Otago Master's student having conducted waste audits at three supermarket chains. It also presents the final destinations of retail waste, which has been used to adjust the waste figure. The share going to Animal Feed, Donation and Protein Reprocessing has been removed from the waste figure.	3.12	(Love Food Hate Waste NZ, 2020)	High Confidence
Norway		89 stores from 3 different retail chains provided data, alongside wholesalers covering a large share of the market, both upscaled to the whole of Norway. It was not possible to disaggregate wholesale. Only edible food reported, and the figures have therefore been adjusted to estimate the entire food waste.	12.93	(Caldeira et al., 2019)	Medium Confidence
		89 stores from 3 different retail chains provided data, alongside wholesalers covering a large share of the market, both upscaled to the whole of Norway. It was not possible to disaggregate wholesale. Only edible food reported, and the figures have therefore been adjusted to estimate the entire food waste.	14.11		Medium Confidence
		89 stores from 3 different retail chains provided data, alongside wholesalers covering a large share of the market, both upscaled to the whole of Norway. It was not possible to disaggregate wholesale. Only edible food reported, and the figures have therefore been adjusted to estimate the entire food waste.	14.39	(Stensgård & Hanssen, 2016)	Medium Confidence
		Retailers report data on waste and sales by product group and cause. Wholesalers also provide estimates this way, these have not been included here. Uses the ForMat definition of food which only measures edible food waste, not inedible parts. It has therefore been adjusted to increase comparability. In this definition, food sent to animal feed is considered waste. It was not possible to adjust and account for this as the share of food going to animal feed was only included for the production stage; it is therefore assumed no food waste is going to animals at other stages.	13.67	(Stensgård et al., 2019)	Medium Confidence

Russian Federation		The paper cites what is assumed to be a waste composition analysis by the Higher School of Economics (which was not found when searched for) and data from Rosstat. In addition, the shares of waste at each stage are calculations based on data from Russian Agriculture Ministry (2017). The estimate provides a total food waste estimate as well as the amount of waste at each stage of the chain, these have been combined to form sector-specific estimates. The inability to trace the original source data and the lack of transparency on the calculations means we cannot have high confidence in this estimate.	13.72	(Tiarcenter, 2019)	Medium Confidence
Saudi Arabia		This study forms the Saudi waste Baseline, conducted by Saudi Grains Organisation (SAGO). For Retail, over 7,000 samples across 19 product groups were taken. It is unclear, however, from how many retailers samples were taken. Wholesale is not disaggregated from Retail so is included. Samples taken across 13 regions in Saudi Arabia. The value taken is the share of total waste attributed to 'Distribution'. Additional information and images to supplement the main study can be found here: https://www.macs-g20.org/fileadmin/macs/Activities/2020_FLW_WS/4_Session_3_FW_at_HH_level_small.pdf	19.65	(SAGO, 2019)	High Confidence
Slovenia		Data from the Slovenian Statistical Office, but the exact methodology is unclear. The methodological explanation from the same site mentions three different annual surveys on waste collection, generation and recovery/disposal, alongside an ad-hoc questionnaire of public waste collection services. It is unclear to whom the surveys are sent (i.e., to waste generators or to waste collection services) and if it requires submission of observed data or some other form of self-reporting.	6.62	(Republic of Slovenia Statistical Office, 2020)	Medium Confidence
Sweden		The paper is produced by Naturvårdsverket, the Swedish Environmental Protection Agency, and is based on industry reporting to the EPA. The summary (in English) does not provide detailed methodology on number of companies reporting.	10.00	(Swedish Environmental Protection Agency, 2020)	High Confidence
United Kingdom of Great Britain and Northern Ireland		Data provided by Retail signatories to Courtauld 2025, which cover more than 95% of the food retail sector (by sales), were used. They were scaled up based on market coverage.	4.20	(WRAP, 2020)	High Confidence
United States of America		US EPA synthesis of food waste consistent with the FLW protocol. Combines waste generation factors from other studies with relevant scaling statistics, such as employees or revenue for a sector. Nine studies were used, a mixture of waste audits and surveys, to form the waste generation factors. Wholesale also estimated, not included in the paper. 9 studies used to inform supermarket and supercenter waste generation rate. Waste management pathways for wholesale/retail were provided, these were used to remove the share donated (21%) and going to animal feed (14%)	15.65	(U.S. Environmental Protection Agency, 2020)	High Confidence

3.4 Bibliography

This bibliography contains all of the studies referenced in the Appendices. For a list only of the references used to inform the Level 1 analysis, see the spreadsheet published alongside the report.

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4 Appendix: Level 1 data by country for all sectors

This section contains three tables – one for each sector – including estimates of food waste for all countries. These estimates include those taken from one or more measured datapoints (classified as *High* or *Medium* confidence) and those extrapolated from other countries' data (classified as *Low* or *Very Low* confidence).

It is important to note that the confidence rating in this report is not a judgement on the quality of the study undertaken, It is an assessment – based on our understanding of the study – of how robust the estimate of food waste is for tracking food waste in the given country. In many cases, this was not an aim of the original study. Hence many good studies will be classified at a 'Medium' confidence level (or even excluded from consideration altogether) as the aims of the paper did not include national food waste tracking.

4.1 Household

See **Erreur ! Source du renvoi introuvable.** in Section **Erreur ! Source du renvoi introuvable.**.

4.2 Food Service

To briefly reiterate the methodology: the best available food waste data was collected, adjusted to account for biases and improve comparability, and grouped into confidence ratings. Where available, the average of these datapoints was applied for a country. Where not available, an extrapolation was made based on the observed estimates. In Food Service, for HICs, the average waste in HICs was used. Due to insufficient regional or income group data in UMC, LMC and LICs, the global average is used in all other cases. The *High* and *Medium* confidence refer only to estimates from the data collected. HIC extrapolations are *Low* confidence and all others are *Very Low* confidence. This methodology is detailed in Appendix Section 1.

Table 13: Level 1 food-service food-waste estimates for each country

Region	M49 code	Country	Food service estimate (kg/capita/year)	Food service estimate (tonnes/year)	Confidence in estimate
Australia and New Zealand	36	Australia	22	546,340	High Confidence
Australia and New Zealand	554	New Zealand	26	122,256	Low Confidence
Central Asia	398	Kazakhstan	28	512,760	Very Low Confidence
Central Asia	417	Kyrgyzstan	28	177,335	Very Low Confidence
Central Asia	762	Tajikistan	28	257,632	Very Low Confidence
Central Asia	795	Turkmenistan	28	164,239	Very Low Confidence
Central Asia	860	Uzbekistan	28	911,613	Very Low Confidence
Eastern Asia	156	China	46	65,377,741	High Confidence
Eastern Asia	344	China, Hong Kong SAR	26	190,070	Low Confidence
Eastern Asia	446	China, Macao SAR	26	16,369	Low Confidence
Eastern Asia	408	Dem. People's Rep. Korea	28	709,413	Very Low Confidence
Eastern Asia	392	Japan	15	1,870,735	Medium Confidence
Eastern Asia	496	Mongolia	28	89,144	Very Low Confidence
Eastern Asia	410	Republic of Korea	26	1,309,322	Low Confidence

Eastern Europe	112	Belarus	28	261,264	Very Low Confidence
Eastern Europe	100	Bulgaria	28	193,483	Very Low Confidence
Eastern Europe	203	Czechia	26	273,217	Low Confidence
Eastern Europe	348	Hungary	26	247,542	Low Confidence
Eastern Europe	616	Poland	26	968,415	Low Confidence
Eastern Europe	498	Republic of Moldova	28	111,757	Very Low Confidence
Eastern Europe	642	Romania	26	494,961	Low Confidence
Eastern Europe	643	Russian Federation	28	4,031,907	Very Low Confidence
Eastern Europe	703	Slovakia	26	139,481	Low Confidence
Eastern Europe	804	Ukraine	28	1,215,982	Very Low Confidence
Latin America and the Caribbean	660	Anguilla	*	*	No Estimate
Latin America and the Caribbean	28	Antigua and Barbuda	26	2,482	Low Confidence
Latin America and the Caribbean	32	Argentina	28	1,237,737	Very Low Confidence
Latin America and the Caribbean	533	Aruba	26	2,717	Low Confidence
Latin America and the Caribbean	44	Bahamas	26	9,956	Low Confidence
Latin America and the Caribbean	52	Barbados	26	7,336	Low Confidence
Latin America and the Caribbean	84	Belize	28	10,791	Very Low Confidence
Latin America and the Caribbean	68	Bolivia (Plurin. State of)	28	318,222	Very Low Confidence
Latin America and the Caribbean	535	Bonaire, St. Eustatius & Saba	*	*	No Estimate
Latin America and the Caribbean	76	Brazil	28	5,833,403	Very Low Confidence
Latin America and the Caribbean	92	British Virgin Islands	26	767	Low Confidence
Latin America and the Caribbean	136	Cayman Islands	26	1,659	Low Confidence
Latin America and the Caribbean	152	Chile	26	484,414	Low Confidence
Latin America and the Caribbean	170	Colombia	28	1,391,380	Very Low Confidence
Latin America and the Caribbean	188	Costa Rica	28	139,516	Very Low Confidence
Latin America and the Caribbean	192	Cuba	28	313,258	Very Low Confidence
Latin America and the Caribbean	531	Curaçao	26	4,177	Low Confidence
Latin America and the Caribbean	212	Dominica	28	1,985	Very Low Confidence
Latin America and the Caribbean	214	Dominican Republic	28	296,826	Very Low Confidence
Latin America and the Caribbean	218	Ecuador	28	480,209	Very Low Confidence
Latin America and the Caribbean	222	El Salvador	28	178,377	Very Low Confidence
Latin America and the Caribbean	238	Falkland Islands (Malvinas)	*	*	No Estimate
Latin America and the Caribbean	254	French Guiana	*	*	No Estimate
Latin America and the Caribbean	308	Grenada	28	3,096	Very Low Confidence

Latin America and the Caribbean	312	Guadeloupe	*	*	No Estimate
Latin America and the Caribbean	320	Guatemala	28	485,952	Very Low Confidence
Latin America and the Caribbean	328	Guyana	28	21,637	Very Low Confidence
Latin America and the Caribbean	332	Haiti	28	311,312	Very Low Confidence
Latin America and the Caribbean	340	Honduras	28	269,382	Very Low Confidence
Latin America and the Caribbean	388	Jamaica	28	81,491	Very Low Confidence
Latin America and the Caribbean	474	Martinique	*	*	No Estimate
Latin America and the Caribbean	484	Mexico	28	3,526,184	Very Low Confidence
Latin America and the Caribbean	500	Montserrat	*	*	No Estimate
Latin America and the Caribbean	558	Nicaragua	28	180,917	Very Low Confidence
Latin America and the Caribbean	591	Panama	26	108,538	Low Confidence
Latin America and the Caribbean	600	Paraguay	28	194,713	Very Low Confidence
Latin America and the Caribbean	604	Peru	28	898,589	Very Low Confidence
Latin America and the Caribbean	630	Puerto Rico	26	74,978	Low Confidence
Latin America and the Caribbean	652	Saint Barthélemy	*	*	No Estimate
Latin America and the Caribbean	659	Saint Kitts and Nevis	26	1,350	Low Confidence
Latin America and the Caribbean	662	Saint Lucia	28	5,053	Very Low Confidence
Latin America and the Caribbean	663	Saint Martin (French part)	26	971	Low Confidence
Latin America and the Caribbean	670	Saint Vincent & Grenadines	28	3,057	Very Low Confidence
Latin America and the Caribbean	534	Sint Maarten (Dutch part)	26	1,084	Low Confidence
Latin America and the Caribbean	740	Suriname	28	16,070	Very Low Confidence
Latin America and the Caribbean	780	Trinidad and Tobago	26	35,656	Low Confidence
Latin America and the Caribbean	796	Turks and Caicos Islands	26	976	Low Confidence
Latin America and the Caribbean	850	United States Virgin Islands	26	2,674	Low Confidence
Latin America and the Caribbean	858	Uruguay	26	88,481	Low Confidence
Latin America and the Caribbean	862	Venezuela (Boliv. Rep. of)	28	788,176	Very Low Confidence
Melanesia	242	Fiji	28	24,600	Very Low Confidence
Melanesia	540	New Caledonia	26	7,228	Low Confidence
Melanesia	598	Papua New Guinea	28	242,571	Very Low Confidence
Melanesia	90	Solomon Islands	28	18,513	Very Low Confidence
Melanesia	548	Vanuatu	28	8,289	Very Low Confidence
Micronesia	316	Guam	26	4,276	Low Confidence
Micronesia	296	Kiribati	28	3,250	Very Low Confidence
Micronesia	584	Marshall Islands	28	1,625	Very Low Confidence

Micronesia	583	Micronesia (Fed. States of)	28	3,145	Very Low Confidence
Micronesia	520	Nauru	26	276	Low Confidence
Micronesia	580	Northern Mariana Islands	26	1,462	Low Confidence
Micronesia	585	Palau	26	460	Low Confidence
Northern Africa	12	Algeria	28	1,189,987	Very Low Confidence
Northern Africa	818	Egypt	28	2,774,725	Very Low Confidence
Northern Africa	434	Libya	28	187,330	Very Low Confidence
Northern Africa	504	Morocco	28	1,008,080	Very Low Confidence
Northern Africa	729	Sudan	28	1,183,356	Very Low Confidence
Northern Africa	788	Tunisia	28	323,241	Very Low Confidence
Northern Africa	732	Western Sahara	*	*	No Estimate
Northern America	60	Bermuda	26	1,598	Low Confidence
Northern America	124	Canada	26	956,228	Low Confidence
Northern America	304	Greenland	26	1,449	Low Confidence
Northern America	666	Saint Pierre and Miquelon	*	*	No Estimate
Northern America	840	United States of America	64	20,934,827	High Confidence
Northern Europe	208	Denmark	21	119,134	High Confidence
Northern Europe	233	Estonia	17	22,013	High Confidence
Northern Europe	234	Faroe Islands	26	1,245	Low Confidence
Northern Europe	246	Finland	23	128,927	Medium Confidence
Northern Europe	352	Iceland	26	8,665	Low Confidence
Northern Europe	372	Ireland	56	274,135	Medium Confidence
Northern Europe	833	Isle of Man	26	2,162	Low Confidence
Northern Europe	428	Latvia	26	48,735	Low Confidence
Northern Europe	440	Lithuania	26	70,536	Low Confidence
Northern Europe	578	Norway	5	26,685	Medium Confidence
Northern Europe	752	Sweden	21	205,746	High Confidence
Northern Europe	826	United Kingdom	17	1,114,248	High Confidence
Polynesia	16	American Samoa	28	1,528	Very Low Confidence
Polynesia	184	Cook Islands	*	*	No Estimate
Polynesia	258	French Polynesia	26	7,139	Low Confidence
Polynesia	570	Niue	*	*	No Estimate
Polynesia	882	Samoa	28	5,448	Very Low Confidence
Polynesia	772	Tokelau	*	*	No Estimate
Polynesia	776	Tonga	28	2,888	Very Low Confidence

Polynesia	798	Tuvalu	28	321	Very Low Confidence
Polynesia	876	Wallis and Futuna Islands	*	*	No Estimate
South-eastern Asia	96	Brunei Darussalam	26	11,075	Low Confidence
South-eastern Asia	116	Cambodia	28	455,686	Very Low Confidence
South-eastern Asia	360	Indonesia	28	7,480,085	Very Low Confidence
South-eastern Asia	418	Lao People's Dem. Rep.	28	198,165	Very Low Confidence
South-eastern Asia	458	Malaysia	90	2,861,537	Medium Confidence
South-eastern Asia	104	Myanmar	28	1,493,814	Very Low Confidence
South-eastern Asia	608	Philippines	28	2,988,340	Very Low Confidence
South-eastern Asia	702	Singapore	26	148,358	Low Confidence
South-eastern Asia	764	Thailand	28	1,924,450	Very Low Confidence
South-eastern Asia	626	Timor-Leste	28	35,741	Very Low Confidence
South-eastern Asia	704	Viet Nam	28	2,666,210	Very Low Confidence
Southern Asia	4	Afghanistan	28	1,051,474	Very Low Confidence
Southern Asia	50	Bangladesh	3	544,436	Medium Confidence
Southern Asia	64	Bhutan	28	21,092	Very Low Confidence
Southern Asia	356	India	28	37,767,754	Very Low Confidence
Southern Asia	364	Iran (Islamic Republic of)	28	2,291,738	Very Low Confidence
Southern Asia	462	Maldives	28	14,677	Very Low Confidence
Southern Asia	524	Nepal	28	790,744	Very Low Confidence
Southern Asia	586	Pakistan	28	5,985,859	Very Low Confidence
Southern Asia	144	Sri Lanka	28	589,387	Very Low Confidence
Southern Europe	8	Albania	28	79,628	Very Low Confidence
Southern Europe	20	Andorra	26	1,971	Low Confidence
Southern Europe	70	Bosnia and Herzegovina	28	91,240	Very Low Confidence
Southern Europe	191	Croatia	26	105,571	Low Confidence
Southern Europe	292	Gibraltar	26	861	Low Confidence
Southern Europe	300	Greece	26	267,703	Low Confidence
Southern Europe	336	Holy See	*	*	No Estimate
Southern Europe	380	Italy	26	1,547,665	Low Confidence
Southern Europe	470	Malta	26	11,257	Low Confidence
Southern Europe	499	Montenegro	28	17,358	Very Low Confidence
Southern Europe	807	North Macedonia	28	57,588	Very Low Confidence
Southern Europe	620	Portugal	26	261,382	Low Confidence
Southern Europe	674	San Marino	26	866	Low Confidence

Southern Europe	688	Serbia	6	52,633	Medium Confidence
Southern Europe	705	Slovenia	20	41,354	Medium Confidence
Southern Europe	724	Spain	26	1,194,596	Low Confidence
Sub-Saharan Africa	24	Angola	28	879,650	Very Low Confidence
Sub-Saharan Africa	204	Benin	28	326,185	Very Low Confidence
Sub-Saharan Africa	72	Botswana	28	63,674	Very Low Confidence
Sub-Saharan Africa	854	Burkina Faso	28	561,683	Very Low Confidence
Sub-Saharan Africa	108	Burundi	28	318,705	Very Low Confidence
Sub-Saharan Africa	132	Cabo Verde	28	15,199	Very Low Confidence
Sub-Saharan Africa	120	Cameroon	28	715,223	Very Low Confidence
Sub-Saharan Africa	140	Central African Republic	28	131,157	Very Low Confidence
Sub-Saharan Africa	148	Chad	28	440,772	Very Low Confidence
Sub-Saharan Africa	174	Comoros	28	23,519	Very Low Confidence
Sub-Saharan Africa	178	Congo	28	148,717	Very Low Confidence
Sub-Saharan Africa	384	Côte d'Ivoire	28	710,803	Very Low Confidence
Sub-Saharan Africa	180	Dem. Rep. of the Congo	28	2,398,890	Very Low Confidence
Sub-Saharan Africa	262	Djibouti	28	26,910	Very Low Confidence
Sub-Saharan Africa	226	Equatorial Guinea	28	37,480	Very Low Confidence
Sub-Saharan Africa	232	Eritrea	28	96,660	Very Low Confidence
Sub-Saharan Africa	748	Eswatini	28	31,733	Very Low Confidence
Sub-Saharan Africa	231	Ethiopia	28	3,097,852	Very Low Confidence
Sub-Saharan Africa	266	Gabon	28	60,051	Very Low Confidence
Sub-Saharan Africa	270	Gambia	28	64,890	Very Low Confidence
Sub-Saharan Africa	288	Ghana	28	840,750	Very Low Confidence
Sub-Saharan Africa	324	Guinea	28	352,996	Very Low Confidence
Sub-Saharan Africa	624	Guinea-Bissau	28	53,094	Very Low Confidence
Sub-Saharan Africa	404	Kenya	31	1,637,020	Medium Confidence
Sub-Saharan Africa	426	Lesotho	28	58,743	Very Low Confidence
Sub-Saharan Africa	430	Liberia	28	136,470	Very Low Confidence
Sub-Saharan Africa	450	Madagascar	28	745,431	Very Low Confidence
Sub-Saharan Africa	454	Malawi	28	514,897	Very Low Confidence
Sub-Saharan Africa	466	Mali	28	543,347	Very Low Confidence
Sub-Saharan Africa	478	Mauritania	28	125,090	Very Low Confidence
Sub-Saharan Africa	480	Mauritius	26	32,454	Low Confidence
Sub-Saharan Africa	175	Mayotte	*	*	No Estimate

Sub-Saharan Africa	508	Mozambique	28	839,315	Very Low Confidence
Sub-Saharan Africa	516	Namibia	28	68,948	Very Low Confidence
Sub-Saharan Africa	562	Niger	28	644,307	Very Low Confidence
Sub-Saharan Africa	566	Nigeria	28	5,554,629	Very Low Confidence
Sub-Saharan Africa	638	Réunion	*	*	No Estimate
Sub-Saharan Africa	646	Rwanda	28	349,010	Very Low Confidence
Sub-Saharan Africa	654	Saint Helena	*	*	No Estimate
Sub-Saharan Africa	678	Sao Tome and Principe	28	5,945	Very Low Confidence
Sub-Saharan Africa	686	Senegal	28	450,432	Very Low Confidence
Sub-Saharan Africa	690	Seychelles	26	2,497	Low Confidence
Sub-Saharan Africa	694	Sierra Leone	28	215,957	Very Low Confidence
Sub-Saharan Africa	706	Somalia	28	426,841	Very Low Confidence
Sub-Saharan Africa	710	South Africa	28	1,618,550	Very Low Confidence
Sub-Saharan Africa	728	South Sudan	28	305,756	Very Low Confidence
Sub-Saharan Africa	768	Togo	28	223,397	Very Low Confidence
Sub-Saharan Africa	800	Uganda	28	1,223,611	Very Low Confidence
Sub-Saharan Africa	834	United Rep. of Tanzania	28	1,603,271	Very Low Confidence
Sub-Saharan Africa	894	Zambia	28	493,678	Very Low Confidence
Sub-Saharan Africa	716	Zimbabwe	28	404,801	Very Low Confidence
Western Asia	51	Armenia	28	81,751	Very Low Confidence
Western Asia	31	Azerbaijan	28	277,718	Very Low Confidence
Western Asia	48	Bahrain	26	41,949	Low Confidence
Western Asia	196	Cyprus	26	30,636	Low Confidence
Western Asia	268	Georgia	28	110,471	Very Low Confidence
Western Asia	368	Iraq	28	1,086,522	Very Low Confidence
Western Asia	376	Israel	27	233,752	Medium Confidence
Western Asia	400	Jordan	28	279,211	Very Low Confidence
Western Asia	414	Kuwait	26	107,534	Low Confidence
Western Asia	422	Lebanon	28	189,491	Very Low Confidence
Western Asia	512	Oman	26	127,161	Low Confidence
Western Asia	634	Qatar	26	72,389	Low Confidence
Western Asia	682	Saudi Arabia	26	875,905	Low Confidence
Western Asia	275	State of Palestine	28	137,686	Very Low Confidence
Western Asia	760	Syrian Arab Republic	28	471,817	Very Low Confidence
Western Asia	792	Turkey	28	2,305,992	Very Low Confidence

Western Asia	784	United Arab Emirates	26	249,735	Low Confidence
Western Asia	887	Yemen	28	806,034	Very Low Confidence
Western Europe	40	Austria	28	254,191	High Confidence
Western Europe	56	Belgium	20	227,371	Medium Confidence
Western Europe	250	France	24	1,594,579	Medium Confidence
Western Europe	276	Germany	21	1,718,433	High Confidence
Western Europe	438	Liechtenstein	26	971	Low Confidence
Western Europe	442	Luxembourg	21	12,868	Medium Confidence
Western Europe	492	Monaco	26	997	Low Confidence
Western Europe	528	Netherlands	26	437,003	Low Confidence
Western Europe	756	Switzerland	40	343,656	Medium Confidence
	830	Channel Islands	*	*	No Estimate
	158	Other non-specified areas	*	*	No Estimate

4.3 Retail

To briefly reiterate the methodology: the best available food waste data was collected, adjusted to account for biases and improve comparability, and grouped into confidence ratings. Where available, the average of these datapoints was applied for a country. Where not available, an extrapolation was made based on the observed estimates. In Retail, for HICs, the average waste in HICs was used. Due to insufficient regional or income group data in UMC, LMC and LICs, the global average is used in all other cases. The *High* and *Medium* confidence refer only to estimates from the data collected. HIC extrapolations are *Low* confidence and all others are *Very Low* confidence. This methodology is detailed in Appendix Section 1.

Table 14: Level 1 retail food-waste estimates for each country

Region	M49 code	Country	Retail estimate (kg/capita/year)	Retail estimate (tonnes/year)	Confidence in estimate
Australia and New Zealand	36	Australia	9	238,248	High Confidence
Australia and New Zealand	554	New Zealand	3	14,923	High Confidence
Central Asia	398	Kazakhstan	16	290,121	Very Low Confidence
Central Asia	417	Kyrgyzstan	16	100,337	Very Low Confidence
Central Asia	762	Tajikistan	16	145,769	Very Low Confidence
Central Asia	795	Turkmenistan	16	92,927	Very Low Confidence
Central Asia	860	Uzbekistan	16	515,793	Very Low Confidence
Eastern Asia	156	China	16	22,422,617	Very Low Confidence
Eastern Asia	344	China, Hong Kong SAR	13	95,255	Low Confidence
Eastern Asia	446	China, Macao SAR	13	8,203	Low Confidence
Eastern Asia	408	Dem. People's Rep. Korea	16	401,388	Very Low Confidence
Eastern Asia	392	Japan	9	1,095,308	Medium Confidence
Eastern Asia	496	Mongolia	16	50,438	Very Low Confidence
Eastern Asia	410	Republic of Korea	13	656,177	Low Confidence
Eastern Europe	112	Belarus	16	147,824	Very Low Confidence
Eastern Europe	100	Bulgaria	16	109,473	Very Low Confidence
Eastern Europe	203	Czechia	13	136,925	Low Confidence
Eastern Europe	348	Hungary	13	124,057	Low Confidence
Eastern Europe	616	Poland	13	485,329	Low Confidence
Eastern Europe	498	Republic of Moldova	16	63,232	Very Low Confidence
Eastern Europe	642	Romania	13	248,053	Low Confidence
Eastern Europe	643	Russian Federation	14	2,001,062	Medium Confidence
Eastern Europe	703	Slovakia	13	69,902	Low Confidence
Eastern Europe	804	Ukraine	16	688,006	Very Low Confidence
Latin America and the Caribbean	660	Anguilla	*	*	No Estimate

Latin America and the Caribbean	28	Antigua and Barbuda	13	1,244	Low Confidence
Latin America and the Caribbean	32	Argentina	16	700,315	Very Low Confidence
Latin America and the Caribbean	533	Aruba	13	1,362	Low Confidence
Latin America and the Caribbean	44	Bahamas	13	4,989	Low Confidence
Latin America and the Caribbean	52	Barbados	13	3,676	Low Confidence
Latin America and the Caribbean	84	Belize	16	6,105	Very Low Confidence
Latin America and the Caribbean	68	Bolivia (Plurin. State of)	16	180,051	Very Low Confidence
Latin America and the Caribbean	535	Bonaire, St. Eustatius & Saba	*	*	No Estimate
Latin America and the Caribbean	76	Brazil	16	3,300,555	Very Low Confidence
Latin America and the Caribbean	92	British Virgin Islands	13	384	Low Confidence
Latin America and the Caribbean	136	Cayman Islands	13	831	Low Confidence
Latin America and the Caribbean	152	Chile	13	242,768	Low Confidence
Latin America and the Caribbean	170	Colombia	16	787,246	Very Low Confidence
Latin America and the Caribbean	188	Costa Rica	16	78,938	Very Low Confidence
Latin America and the Caribbean	192	Cuba	16	177,242	Very Low Confidence
Latin America and the Caribbean	531	Curaçao	13	2,093	Low Confidence
Latin America and the Caribbean	212	Dominica	16	1,123	Very Low Confidence
Latin America and the Caribbean	214	Dominican Republic	16	167,945	Very Low Confidence
Latin America and the Caribbean	218	Ecuador	16	271,703	Very Low Confidence
Latin America and the Caribbean	222	El Salvador	16	100,926	Very Low Confidence
Latin America and the Caribbean	238	Falkland Islands (Malvinas)	*	*	No Estimate
Latin America and the Caribbean	254	French Guiana	*	*	No Estimate
Latin America and the Caribbean	308	Grenada	16	1,752	Very Low Confidence
Latin America and the Caribbean	312	Guadeloupe	*	*	No Estimate
Latin America and the Caribbean	320	Guatemala	16	274,953	Very Low Confidence
Latin America and the Caribbean	328	Guyana	16	12,242	Very Low Confidence
Latin America and the Caribbean	332	Haiti	16	176,141	Very Low Confidence
Latin America and the Caribbean	340	Honduras	16	152,417	Very Low Confidence
Latin America and the Caribbean	388	Jamaica	16	46,108	Very Low Confidence
Latin America and the Caribbean	474	Martinique	*	*	No Estimate
Latin America and the Caribbean	484	Mexico	16	1,995,124	Very Low Confidence
Latin America and the Caribbean	500	Montserrat	*	*	No Estimate
Latin America and the Caribbean	558	Nicaragua	16	102,364	Very Low Confidence
Latin America and the Caribbean	591	Panama	13	54,395	Low Confidence

Latin America and the Caribbean	600	Paraguay	16	110,169	Very Low Confidence
Latin America and the Caribbean	604	Peru	16	508,424	Very Low Confidence
Latin America and the Caribbean	630	Puerto Rico	13	37,576	Low Confidence
Latin America and the Caribbean	652	Saint Barthélemy	*	*	No Estimate
Latin America and the Caribbean	659	Saint Kitts and Nevis	13	676	Low Confidence
Latin America and the Caribbean	662	Saint Lucia	16	2,859	Very Low Confidence
Latin America and the Caribbean	663	Saint Martin (French part)	13	487	Low Confidence
Latin America and the Caribbean	670	Saint Vincent & Grenadines	16	1,730	Very Low Confidence
Latin America and the Caribbean	534	Sint Maarten (Dutch part)	13	543	Low Confidence
Latin America and the Caribbean	740	Suriname	16	9,092	Very Low Confidence
Latin America and the Caribbean	780	Trinidad and Tobago	13	17,869	Low Confidence
Latin America and the Caribbean	796	Turks and Caicos Islands	13	489	Low Confidence
Latin America and the Caribbean	850	United States Virgin Islands	13	1,340	Low Confidence
Latin America and the Caribbean	858	Uruguay	13	44,343	Low Confidence
Latin America and the Caribbean	862	Venezuela (Boliv. Rep. of)	16	445,952	Very Low Confidence
Melanesia	242	Fiji	16	13,919	Very Low Confidence
Melanesia	540	New Caledonia	13	3,623	Low Confidence
Melanesia	598	Papua New Guinea	16	137,247	Very Low Confidence
Melanesia	90	Solomon Islands	16	10,475	Very Low Confidence
Melanesia	548	Vanuatu	16	4,690	Very Low Confidence
Micronesia	316	Guam	13	2,143	Low Confidence
Micronesia	296	Kiribati	16	1,839	Very Low Confidence
Micronesia	584	Marshall Islands	16	920	Very Low Confidence
Micronesia	583	Micronesia (Fed. States of)	16	1,780	Very Low Confidence
Micronesia	520	Nauru	13	138	Low Confidence
Micronesia	580	Northern Mariana Islands	13	733	Low Confidence
Micronesia	585	Palau	13	231	Low Confidence
Northern Africa	12	Algeria	16	673,298	Very Low Confidence
Northern Africa	818	Egypt	16	1,569,947	Very Low Confidence
Northern Africa	434	Libya	16	105,992	Very Low Confidence
Northern Africa	504	Morocco	16	570,374	Very Low Confidence
Northern Africa	729	Sudan	16	669,546	Very Low Confidence
Northern Africa	788	Tunisia	16	182,891	Very Low Confidence
Northern Africa	732	Western Sahara	*	*	No Estimate
Northern America	60	Bermuda	13	801	Low Confidence

Northern America	124	Canada	13	479,221	Low Confidence
Northern America	304	Greenland	13	726	Low Confidence
Northern America	666	Saint Pierre and Miquelon	*	*	No Estimate
Northern America	840	United States of America	16	5,151,313	High Confidence
Northern Europe	208	Denmark	30	172,003	High Confidence
Northern Europe	233	Estonia	5	6,243	Medium Confidence
Northern Europe	234	Faroe Islands	13	624	Low Confidence
Northern Europe	246	Finland	13	70,865	Low Confidence
Northern Europe	352	Iceland	13	4,342	Low Confidence
Northern Europe	372	Ireland	13	62,543	Low Confidence
Northern Europe	833	Isle of Man	13	1,084	Low Confidence
Northern Europe	428	Latvia	13	24,424	Low Confidence
Northern Europe	440	Lithuania	13	35,349	Low Confidence
Northern Europe	578	Norway	14	74,088	Medium Confidence
Northern Europe	752	Sweden	10	100,364	High Confidence
Northern Europe	826	United Kingdom	4	283,627	High Confidence
Polynesia	16	American Samoa	16	865	Very Low Confidence
Polynesia	184	Cook Islands	*	*	No Estimate
Polynesia	258	French Polynesia	13	3,578	Low Confidence
Polynesia	570	Niue	*	*	No Estimate
Polynesia	882	Samoa	16	3,082	Very Low Confidence
Polynesia	772	Tokelau	*	*	No Estimate
Polynesia	776	Tonga	16	1,634	Very Low Confidence
Polynesia	798	Tuvalu	16	181	Very Low Confidence
Polynesia	876	Wallis and Futuna Islands	*	*	No Estimate
South-eastern Asia	96	Brunei Darussalam	13	5,550	Low Confidence
South-eastern Asia	116	Cambodia	16	257,829	Very Low Confidence
South-eastern Asia	360	Indonesia	16	4,232,252	Very Low Confidence
South-eastern Asia	418	Lao People's Dem. Rep.	16	112,122	Very Low Confidence
South-eastern Asia	458	Malaysia	79	2,518,199	Medium Confidence
South-eastern Asia	104	Myanmar	16	845,204	Very Low Confidence
South-eastern Asia	608	Philippines	16	1,690,811	Very Low Confidence
South-eastern Asia	702	Singapore	13	74,351	Low Confidence
South-eastern Asia	764	Thailand	16	1,088,859	Very Low Confidence
South-eastern Asia	626	Timor-Leste	16	20,222	Very Low Confidence

South-eastern Asia	704	Viet Nam	16	1,508,549	Very Low Confidence
Southern Asia	4	Afghanistan	16	594,927	Very Low Confidence
Southern Asia	50	Bangladesh	16	2,549,842	Very Low Confidence
Southern Asia	64	Bhutan	16	11,934	Very Low Confidence
Southern Asia	356	India	16	21,369,097	Very Low Confidence
Southern Asia	364	Iran (Islamic Republic of)	16	1,296,672	Very Low Confidence
Southern Asia	462	Maldives	16	8,304	Very Low Confidence
Southern Asia	524	Nepal	16	447,405	Very Low Confidence
Southern Asia	586	Pakistan	16	3,386,815	Very Low Confidence
Southern Asia	144	Sri Lanka	16	333,476	Very Low Confidence
Southern Europe	8	Albania	16	45,054	Very Low Confidence
Southern Europe	20	Andorra	13	988	Low Confidence
Southern Europe	70	Bosnia and Herzegovina	16	51,624	Very Low Confidence
Southern Europe	191	Croatia	13	52,908	Low Confidence
Southern Europe	292	Gibraltar	13	432	Low Confidence
Southern Europe	300	Greece	7	77,332	Medium Confidence
Southern Europe	336	Holy See	*	*	No Estimate
Southern Europe	380	Italy	4	219,552	High Confidence
Southern Europe	470	Malta	13	5,641	Low Confidence
Southern Europe	499	Montenegro	16	9,821	Very Low Confidence
Southern Europe	807	North Macedonia	16	32,583	Very Low Confidence
Southern Europe	620	Portugal	13	130,994	Low Confidence
Southern Europe	674	San Marino	13	434	Low Confidence
Southern Europe	688	Serbia	16	137,186	Very Low Confidence
Southern Europe	705	Slovenia	7	13,771	Medium Confidence
Southern Europe	724	Spain	13	598,681	Low Confidence
Sub-Saharan Africa	24	Angola	16	497,709	Very Low Confidence
Sub-Saharan Africa	204	Benin	16	184,556	Very Low Confidence
Sub-Saharan Africa	72	Botswana	16	36,027	Very Low Confidence
Sub-Saharan Africa	854	Burkina Faso	16	317,802	Very Low Confidence
Sub-Saharan Africa	108	Burundi	16	180,324	Very Low Confidence
Sub-Saharan Africa	132	Cabo Verde	16	8,600	Very Low Confidence
Sub-Saharan Africa	120	Cameroon	16	404,675	Very Low Confidence
Sub-Saharan Africa	140	Central African Republic	16	74,209	Very Low Confidence
Sub-Saharan Africa	148	Chad	16	249,390	Very Low Confidence

Sub-Saharan Africa	174	Comoros	16	13,307	Very Low Confidence
Sub-Saharan Africa	178	Congo	16	84,144	Very Low Confidence
Sub-Saharan Africa	384	Côte d'Ivoire	16	402,174	Very Low Confidence
Sub-Saharan Africa	180	Dem. Rep. of the Congo	16	1,357,298	Very Low Confidence
Sub-Saharan Africa	262	Djibouti	16	15,226	Very Low Confidence
Sub-Saharan Africa	226	Equatorial Guinea	16	21,206	Very Low Confidence
Sub-Saharan Africa	232	Eritrea	16	54,690	Very Low Confidence
Sub-Saharan Africa	748	Eswatini	16	17,955	Very Low Confidence
Sub-Saharan Africa	231	Ethiopia	16	1,752,773	Very Low Confidence
Sub-Saharan Africa	266	Gabon	16	33,977	Very Low Confidence
Sub-Saharan Africa	270	Gambia	16	36,715	Very Low Confidence
Sub-Saharan Africa	288	Ghana	16	475,699	Very Low Confidence
Sub-Saharan Africa	324	Guinea	16	199,726	Very Low Confidence
Sub-Saharan Africa	624	Guinea-Bissau	16	30,041	Very Low Confidence
Sub-Saharan Africa	404	Kenya	11	576,411	Medium Confidence
Sub-Saharan Africa	426	Lesotho	16	33,237	Very Low Confidence
Sub-Saharan Africa	430	Liberia	16	77,215	Very Low Confidence
Sub-Saharan Africa	450	Madagascar	16	421,767	Very Low Confidence
Sub-Saharan Africa	454	Malawi	16	291,330	Very Low Confidence
Sub-Saharan Africa	466	Mali	16	307,427	Very Low Confidence
Sub-Saharan Africa	478	Mauritania	16	70,776	Very Low Confidence
Sub-Saharan Africa	480	Mauritius	13	16,264	Low Confidence
Sub-Saharan Africa	175	Mayotte	*	*	No Estimate
Sub-Saharan Africa	508	Mozambique	16	474,887	Very Low Confidence
Sub-Saharan Africa	516	Namibia	16	39,011	Very Low Confidence
Sub-Saharan Africa	562	Niger	16	364,551	Very Low Confidence
Sub-Saharan Africa	566	Nigeria	16	3,142,824	Very Low Confidence
Sub-Saharan Africa	638	Réunion	*	*	No Estimate
Sub-Saharan Africa	646	Rwanda	16	197,471	Very Low Confidence
Sub-Saharan Africa	654	Saint Helena	*	*	No Estimate
Sub-Saharan Africa	678	Sao Tome and Principe	16	3,364	Very Low Confidence
Sub-Saharan Africa	686	Senegal	16	254,856	Very Low Confidence
Sub-Saharan Africa	690	Seychelles	13	1,252	Low Confidence
Sub-Saharan Africa	694	Sierra Leone	16	122,189	Very Low Confidence
Sub-Saharan Africa	706	Somalia	16	241,508	Very Low Confidence

Sub-Saharan Africa	710	South Africa	16	915,780	Very Low Confidence
Sub-Saharan Africa	728	South Sudan	16	172,998	Very Low Confidence
Sub-Saharan Africa	768	Togo	16	126,399	Very Low Confidence
Sub-Saharan Africa	800	Uganda	16	692,322	Very Low Confidence
Sub-Saharan Africa	834	United Rep. of Tanzania	16	907,135	Very Low Confidence
Sub-Saharan Africa	894	Zambia	16	279,324	Very Low Confidence
Sub-Saharan Africa	716	Zimbabwe	16	229,038	Very Low Confidence
Western Asia	51	Armenia	16	46,255	Very Low Confidence
Western Asia	31	Azerbaijan	16	157,134	Very Low Confidence
Western Asia	48	Bahrain	13	21,023	Low Confidence
Western Asia	196	Cyprus	13	15,354	Low Confidence
Western Asia	268	Georgia	16	62,505	Very Low Confidence
Western Asia	368	Iraq	16	614,757	Very Low Confidence
Western Asia	376	Israel	51	437,997	Medium Confidence
Western Asia	400	Jordan	16	157,978	Very Low Confidence
Western Asia	414	Kuwait	13	53,891	Low Confidence
Western Asia	422	Lebanon	16	107,215	Very Low Confidence
Western Asia	512	Oman	13	63,728	Low Confidence
Western Asia	634	Qatar	13	36,278	Low Confidence
Western Asia	682	Saudi Arabia	20	673,502	High Confidence
Western Asia	275	State of Palestine	16	77,903	Very Low Confidence
Western Asia	760	Syrian Arab Republic	16	266,955	Very Low Confidence
Western Asia	792	Turkey	16	1,304,737	Very Low Confidence
Western Asia	784	United Arab Emirates	13	125,157	Low Confidence
Western Asia	887	Yemen	16	456,056	Very Low Confidence
Western Europe	40	Austria	9	77,289	High Confidence
Western Europe	56	Belgium	10	112,100	Medium Confidence
Western Europe	250	France	26	1,667,568	Medium Confidence
Western Europe	276	Germany	6	498,244	High Confidence
Western Europe	438	Liechtenstein	13	487	Low Confidence
Western Europe	442	Luxembourg	7	4,454	Medium Confidence
Western Europe	492	Monaco	13	500	Low Confidence
Western Europe	528	Netherlands	11	188,068	Medium Confidence
Western Europe	756	Switzerland	13	110,053	Low Confidence

5 Appendix: Measurement methods appropriate for each sector

The following methods have been deemed appropriate for each relevant sector for Level 2 and Level 3.

Table 15: Measurement methods for Manufacturing

Waste stream	Appropriate measurement methods	Appropriate means for national government to obtain the measurements from companies
Food waste in a container (single stream – not mixed with other wastes)	Use of records specifying volume or mass e.g., from waste contractor Volume assessment Weighing, of whole containers or samples	Use of nationally held records e.g., regulatory returns Audit (face-to-face survey) to take measurements Self-completion or telephone survey – to request/require provision of measurement data Data provision as part of a framework to tackle food waste (e.g., a voluntary agreement)
Food waste in a container (mixed with other wastes)	Weighing, via waste composition analysis or trial weighings Volume assessment	
Uncontained food waste (not mixed with other wastes and not discharged to sewer)	Weighing, of samples or entire stream depending on feasibility Volume assessment	
Waste discharged to sewer (for Level 3)	Use of biological / chemical oxygen demand (BOD and COD), suspended solids (SS). For further advice see: https://www.wrap.org.uk/sites/files/wrap/food-waste-in-effluent-guidelines_1.pdf	
All waste streams	Waste coefficients applied to material flow Mass balance (i.e., inputs minus outputs)	

It is possible that food manufacture companies keep records of their waste already. Companies may call it something other than waste e.g., leakage, slippage, residue, etc. Therefore, a degree of relationship building and understanding between governments and food manufacturers/processors in the country may need to be built before either understands whether it is possible to use company records to build a national picture.

Informal food processing may not be at the scale necessary to quantify under 12.3.1(b) but this should be an informed decision. It is possible that informal processing occurs on farm or in some households as local business in rural areas. Food removed from the human supply chain in those cases may either be picked up in 12.3.1(b) or as part of in-home consumption under 'household' studies. If the latter, it may be useful to use diaries or surveys to determine how much food waste is likely to be discarded for that reason.

Table 16: Measurement methods for Retail

Waste stream	Appropriate measurement methods	Appropriate means for national government to obtain the measurements from companies
Food waste in a container (single stream – not mixed with other wastes)	Use of records specifying volume or mass e.g., from waste contractor (direct measurement) Waste composition analysis Scanning items as they are wasted Volume assessment Weighing, of whole containers or samples	Use of nationally held records e.g., regulatory returns Audit (face-to-face survey) to take measurements Self-completion or telephone survey – to request/require provision of measurement data Data provision as part of a framework to tackle food waste (e.g., a voluntary agreement)
Food waste in a container (mixed with other wastes)	Use of records specifying volume or mass e.g., from waste contractor (direct measurement) Waste composition analysis Scanning items as they are wasted	

The methods appropriate for formal and informal retail differ slightly. First, informal retail is unlikely to keep records so weighing or volume assessments are necessary. Secondly, the manner of scaling any measurements for informal retail is likely to be difficult. If informal retail is a large proportion of food retail in a country, an effort will have to be made to quantify the number and type of informal food retailers across different geographic areas. This will help to determine a sample frame for the measurement studies and provide the basis for scaling. However, it is likely that the study on number and type of informal retailers will need to be repeated as a country's retail market changes between reporting periods.

Table 17: Measurement methods for Food Service

Waste stream	Appropriate measurement methods	Appropriate means for national government to obtain the measurements from companies
Food waste in a container (single stream – not mixed with other wastes)	Use of records specifying volume or mass e.g., from waste contractor Scanning items as they are wasted	Use of nationally held records e.g., regulatory returns Audit (face-to-face survey) to take measurements Self-completion or telephone survey – to request/require provision of measurement data Data provision as part of a framework to tackle food waste (e.g., a voluntary agreement)
Food waste in a food waste-only container shared with other businesses or households	Volume assessment Weighing, of whole containers or samples *Intercepting waste when shared with other businesses or households*	
Food waste in a container (mixed with other wastes)	Weighing, via waste composition analysis or trial weighing Volume assessment *Intercepting waste when shared with other businesses or households*	
Food waste in a container mixed with other wastes and shared with other businesses or households		
Uncontained food waste (not mixed with other wastes and not discharged to sewer)	Weighing, via waste composition analysis or trial weighing Volume assessment	

The diversity of entity types within this sector is such that records are unlikely to cover them all. Larger public establishments like hospitals or schools may have records or can be more easily regulated than private organisations. The restaurant sector is likely to be diverse and made up of majority small and medium enterprises, many of which may be informal in certain countries. Appropriate methods for measurement are therefore likely to be volume assessments or weighing in a sample study over a series of site visits. The same challenges for scaling such measurement studies apply here as for informal retail; getting as accurate an understanding of the quantity of waste-producing entities as possible is as important as the measurement study and not likely to be easy. This is directly linked to SDG 11.6.1 and could be measured as part of a waste composition analysis.

Table 18: Measurement methods for Household Sector

Waste stream	Appropriate measurement methods	Appropriate means for national government to obtain the measurements from relevant organisations
Food waste in a container (single stream – not mixed with other wastes)	Use of records specifying volume or mass e.g., from waste contractor Volume assessment Weighing, of whole containers or samples Food waste diaries	Commission organisation to conduct studies and scale up on behalf of governments Directly commission studies and maintain oversight of estimates
Food waste in a container (mixed with other wastes)	Weighing, via waste composition analysis or trial weighing (linked with SDG 11.6.1)	
Uncontained food waste (not mixed with other wastes and not discharged to sewer)	Weighing, via waste composition analysis or trial weighing (linked with SDG 11.6.1) Diaries Volume assessment	
Waste discharged to sewer (for Level 3) and food home composted, animal feed	Diaries Diversion and weighing	

Methods most appropriate for household food waste vary by the destination of that waste. If generation and collection are equivalent, then a synthesis of waste composition analyses of samples of collected waste from around the country with the total waste collected figure can give a relatively accurate picture of food waste generated in the home without conducting a household study. However, this will ignore the amount of waste composted at home. These amounts, if likely to be a smaller part of the waste stream, are likely best quantified by a diary study and scaled via population demographic statistics e.g., number of households. If they are likely to be a larger part of the food waste generated from households, a direct measurement study may be more appropriate using in-home observers or measurement devices. This is directly linked to SDG 11.6.1 and could be measured as part of a waste composition analysis.

6 Appendix: Destinations and food waste

Table 19: Definitions of food-waste destinations

Destination	Definition	Classified as food waste for the purposes of the FWI
Animal feed	Diverting material from the food supply chain[9] (directly or after processing) to animals.	N
Bio-based materials/ biochemical processing	Converting material into industrial products for food and non-food purposes. Examples include creating fibres for packaging material; creating bioplastics (e.g., polylactic acid); making "traditional" materials such as leather or feathers (e.g., for pillows); and rendering fat, oil, or grease into a raw material to make products such as soaps, biodiesel, or cosmetics. "Biochemical processing" does not refer to anaerobic digestion or production of bioethanol through fermentation.	N
Codigestion/ anaerobic digestion	Breaking down material via bacteria in the absence of oxygen. This process generates biogas and nutrient-rich matter. Co-digestion refers to the simultaneous anaerobic digestion of FLW and other organic material in one digester. This destination includes fermentation (converting carbohydrates – such as glucose, fructose, and sucrose – via microbes into alcohols in the absence of oxygen to create products such as biofuels).	Y
Composting/ aerobic processes	Breaking down material via bacteria in oxygen-rich environments. Composting refers to the production of organic material (via aerobic processes) that can be used as a soil amendment.	Y
Controlled combustion	Sending material to a facility that is specifically designed for combustion in a controlled manner, which may include some form of energy recovery (this may also be referred to as incineration or thermal treatment).	Y
Land application	Spreading, spraying, injecting, or incorporating organic material onto or below the surface of the land to enhance soil quality.	Y
Landfill	Sending material to an area of land or an excavated site that is specifically designed and built to receive wastes.	Y
Not harvested/ ploughed-in	Leaving crops that were ready for harvest in the field or tilling them into the soil.	Not applicable
Refuse/ discards/ litter	Abandoning material on land or disposing of it in the sea. This includes open dumps (i.e., uncovered, unlined), open burn (i.e., not in a controlled facility), the portion of harvested crops eaten by pests, and fish discards (the portion of total catch that is thrown away or slipped).	Y
Sewer/ wastewater treatment	Sending material down the sewer (with or without prior treatment), including that which may go to a facility designed to treat wastewater.	Y
Other	Sending material to a destination that is different from the 10 listed above. This destination should be described.	N

[9] Excludes crops intentionally grown for bioenergy, animal feed, seed, or industrial use