People centered approach towards food waste management in the urban environment of Mexico

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VEHICULO PROPIEDAD DE LA DELEGACION ITZAPALAPA
CUMPLIENDO CON LA LEY DE RESIDUOS SOLIDOS
EN BENEFICIO DE LA COMUNIDAD
ITZAPALAPA: UN GOBIERNO DE CONTINUIDAD Y RESULTADOS
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Abstract

A more careful consideration of food waste is needed for planning the urban environment. The research signals links between the organization of individuals, the built environment and food waste management through a study conducted in Mexico. It recognizes the different scales within which solid waste management operates, explores food waste production at household levels, and investigates the urban circumstances that influence its management. This is based on the idea that sustainable food waste management in cities requires a constellation of processes through which a 'people centered' approach offers added value to technical and biological facts. This distinction addresses how urban systems react to waste and what behavioral and structural factors affect current sanitary practices in Mexico. Food waste is a resource-demanding item, which makes for a considerable amount of refuse being disposed of in landfills in developing cities. The existing data shortage on waste generation at household levels debilitates implementation strategies and there is a need for more contextual knowledge associated with waste. The evidence-based study includes an explorative phase on the culture of waste management and a more in-depth examination of domestic waste composition. Mixed data collection tools including a household based survey, a food waste diary and weighing recording system were developed to enquire into the daily practices of waste disposal in households. The contrasting urban environment of Mexico City Metropolitan Area holds indistinctive boundaries between the core and the periphery, which hinder the implementation of integrated environmental plans. External determinants are different modes of urban transformation and internal determinants are building features and their consolidation processes. At the household level, less and more affluents groups responded differently to external environmental stressors. A targeted planning proposition is required for each group. Local alternative waste management is more likely to be implement in less affluent contexts. Further, more effective demand-driven service delivery implies better integration between the formal and informal sectors. The results show that efforts toward securing long-term changes in Mexico and other cities with similar circumstances require creating synergy between education, building consolidation, local infrastructure and social engagement.

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ACRONYMS

AADI	Agencia Australiana para el Desarrollo Internacional
AUSAID	Australian Government Overseas Aid Program
BANOBRAS	Banco Nacional de Obras y Servicios Públicos
BRT	Bus Rapid Transit
CAD	Comité de ayuda al Desarrollo
CDS	Comisión sobre el Desarrollo Sostenible
CBO	Community Based Organisation
CEAMA	Comisión Estatal del Medio Ambiente y Agua
CEDA	Central de Abastos de la Ciudad de México
CESTUR	Centro de Estudios Superiores en Turismo
CEDOC	Centro de Documentación Turística
CID	Cooperación Internacional para el Desarrollo
CONAPO	Consejo Nacional de Población
CTB	Cooperación Técnica Belga
CH_4	Methane
CID	Cooperación Internacional para el Desarrollo
CIDA	Agencia Canadiense de Desarrollo Internacional
CIMMA	Cumbre Infantil Morelense del Medio Ambiente
CIVAC	Ciudad Industrial del Valle de Cuernavaca
CONAPO	Consejo Nacional de Población
CTB	Cooperación Técnica Belga
CONACYT	Consejo Nacional de Ciencia y Tecnología.
CONAGUA	Comisión Nacional del Agua
CONAPO	Consejo Nacional de Población
COMETRAVI	Commission Metropolitana de Transporte y Vialidad
CO_2	Carbone dioxide
DAAD	Deutscher Akademischer Austausch Dienst

DECCW	Department of Environment Climate Change and Water
DGSU	Dirección General de Servicios Urbanos
DF	Distrito Federal
EBS	Environment, Behaviour and Society
EDOMEX	Estado de México
EPA	Environmental Protection Agency
FAO	Food Aid Organisation
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
ILAC	Iniciativa Latinoamericana y Caribeña para el Desarrollo Sostenible
IMSS	Instituto Mexicano de Servicio Social
IMTA	Instituto Mexicano de Tecnología del Agua
INE	Instituto Nacional de Ecología
INEGI	Instituto Nacional de Estadísticas Geografía e Informatica
IPCC	Intergovernmental Panel on Climate Change
ISSSTE	Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado.
JICA	Japan International Cooperation Agency
MCMA	Mexico City Metropolitan Areas
MSW	Municipal Solid Waste
NGO	Non-Governmental Organisation
NSW	New South Wales
OECD	Organisation for Economic Co-operation and Development
PAN	Partido Acción Nacional
PEP	Poverty-Environment Partnership
PMPGIR	Programa Municipal de Prevención y Gestión Integral de los Residuos Sólidos
PRD	Partido de la Revolución Democratica
PRI	Partido Revolucionario Internacional

REMEXMAR	Red Mexicana de Manejo Ambiental de Residuos
RSU	Residuos Sólidos Urbanos
SAU	Sistema de Aseo Urbano
SEI	Sotckholm Environmental Institute
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales
SNIB	Sistema Nacional de Información sobre Biodiversidad
SS	Secretaria de Salud
UN	United Nations
UNDP	United Nations Development Project
UNSD	United Nations Statistics Division
UNU-IAS	United Nation University Institute for Advanced Studies
WHO	World Health Organisation
WRAP	Waste and Resources Action Programme
WTO	World Trade Organisation
ZMVM	Zona Metropolitana del Valle de México

1. Introduction

This introduction provides a map of a research project undertaken on food waste management. It presents the overall intent behind investigating food waste trends in the urban environment and presents contextual conditions in selected settlements that affect urban service procurement as well as the livelihood of urban dwellers. This first chapter explains the research approach and highlights some of its particularities.

1.1 Research background

There is a lack of culture of waste in Mexico. These words, or similar comments to that effect were persistently repeated by waste practitioners, experts and heads of households during many exchanges undertaken in the context of this research project. Such research investigates the urban conditions in which food waste is generated in residential areas. The comments refer, for the most part, to a growing throw away behavior and multi-dimensional sanitary issues affecting large and medium-sized cities in Mexico. The capital produces over 12,000 Mg. of waste daily disposed of in one official sanitary landfill and several other waste disposal sites. It is a concern when efficient measures to preserve natural resources and to improve the social conditions surrounded its management are not implemented. Urban sanitary shortcomings have been known to compromise human health, to damage the natural environment and to influence the livelihood of thousand of individuals. Notwithstanding perceived operational challenges the central region of Mexico faces urban expansion processes that also influence the circumstances of the built environment as well as commodity consumption. The central region is an important economic and political hub which is confronted with in-land migration and strong pressure for the relocation of economic activities. These are often developed at a higher rate than planning and design implementations as well as the procurement of urban services.

In Latin America, urban development models have an impact in the continuity and legitimacy of environmentally sound practices (e.g. waste management). This causes disequilibrium between the physical characteristics of the place and the natural condition of the surrounding environment. Solid waste management, which includes collecting, transporting, treating and in some cases converting discarded items into new products, can be used as an instrument to improve the ecological condition of

cities.[1] For instance, organic waste could be considered as a resource for land application and local approaches such as home and community composting could serve as waste prevention implementations.

Two major environmental issues stand out in most Latin American cities. The first challenge is the worldwide significance of the performance of urban areas. From a global environmental perspective, CO_2 emissions, losses of natural resources, and shortfalls in food supply can be attributed to the performance of cities. The second issue is to find ways to maintain natural resources and biodiversity (UNEP, 1999). The region is highly urban with a large percentage of the population concentrating in metropoles with over 10 million inhabitants such as Mexico City, São Paulo, Buenos Aires, Rio de Janeiro, and other large urban centers such as Lima, Bogotá and Santiago. While urbanization itself does not necessarily have negative implications, unplanned growth is known however to influence the economic, spatial and opportunity divide in major urban areas (UN-Habitat, 2008).

There is a range of possible ways to investigate the food waste people produce and how circumstances related to the built environment shape waste management practices. The journey of examining the contextual circumstances of household waste and food waste composition in residential dwellings led me to numerous debates and introspection about discovering a comprehensible scientific approach to assess the external and internal determinants for food waste behavior and the infrastructural and planning implications at local levels. Much of the inspiration for

[1] Ecological conditions are considered here as the necessary measures for environmental protection and recovery of natural resources. Some parameters of ecological conditions are 1) the improvement of the quality of the air through the reduction of pollutants from human activities, (i.e. reduction of gas emission through traffic control); 2) The maintenance of the land condition by ensuring the ability of the land to sustain life (i.e. to provide local resources, to ensure sustainable habitat for other species, to stimulate a balanced mix of land cover and landscape as an integral part of the urban environment); 3) Clean water sources with the reduction of chemicals and pollutant agents in surface water and the protection of ground water; and 4) The promotion of human health through the reduction of environmental contamination.

exploring different approaches comes from a rationale that appropriate answers are ultimately found in a wider context (Brenner, 2000; Corning, 2005; Hawkins, 2006). Indeed, at the end of the 20th century, Peterson et al. and Coleman brought forward the idea that solving waste issues may require solutions beyond those associated with infrastructure and engineering (Coleman,1998; Peterson, Wunder, & Mueller, 1999). According to them, the formulation of opinions about the way societies could best manage their waste requires explanations radiating from the social realm. Since then, the body of work produced on the social context of waste has increased substantially and what we know today about waste consumption, waste composition, waste policies and planning stem not only from technical contributions but also from research on the collective and individual environmental culture.

This research is evidence-based. Many of the arguments put forward stem from the lessons learned from applied experiences. The research evolved from projects undertaken between 2004 and 2007 which have allowed a deeper understanding of how waste management decisions are made in Mexico. In 2004, I was commissioned by the *Instituto Nacional de Ecología* to conduct a study on the systematization of the existing information regarding municipal compost programs in the central region of Mexico. In 2005, I provided technical support in ecological sanitation training while collaborating with a local NGO in *Tepoztlán,* Mexico. In 2006, I conducted a study on understanding the real value of waste in *Morelos*, Mexico at the Bauhaus-Universität Weimar. This study constituted the first effort to integrate knowledge from waste management to assess the condition of growing urban settlements in the central region of Mexico. A publication in peer-reviewed conference proceedings resulted from this effort.[2] In 2007, I provided scientific support to the *Stadtreinigung Hamburg* within a bilateral cooperation initiative with Hamburg's sister city Dar es Salaam and

[2] For more information, see: Jean-Baptiste N., Bidlingmaier W., 2007. People and waste: understanding the real value of waste in Morelos, Mexico. In Cossu, R. (ED) Sardinia 2007 Eleventh International Waste Management and Landfill Symposium Proceedings. S. Margherita di Pula, Cagliari, Italy 1-5 October 2007. Gagliari: Environmental Sanitary Engineering Centre (CISA)

contributed to workshops on local composting methods in tropical climate. As a result, a manual for producing compost from organic waste in the city of Dar es Salaam was produced. That same year, I concluded a research project on the ecological value of waste in urban areas focusing of the case of Jiutepec, Morelos, Mexico. This work was submitted as a Master's thesis at the Bauhaus Universität-Weimar in 2008 and serves along with the above mentioned practice-orientated activities as a platform for the reflections offered in this present work.

This dissertation argues that understanding the processes by which waste disposal takes place, and viewing it across multidisciplinary layers, helps to ensure continuity in environmentally-sound practices in developing communities. Additionally, it puts forward the contribution of the socio-spatial perspective of waste, which is distinguished by findings of a more passive nature based on livelihood and assets, social capital and education and other factors. The research was conducted under the premise that sustainable food waste management requires an integrated approach which would take into account a practice-based framework combining urban, technical and social factors of food waste production. The research reviews how we discuss food waste issues in cities and identifies organizational changes required in order to transform food losses into a valuable resource for present and future generations.

This dissertation focuses on food waste trends in the urban environment and the social context in which waste habits generate. It aims at contributing to the current environmental debate in Latin America with a layer of explanation associated with food waste management. It includes three main considerations identified:

(1) The arrangements of a group of individuals within the space
(2) The production and management of food waste constrained by the space
(3) Factors that facilitate or impede sustainable practices within the space.

The empirical approach integrates viewpoints from the disciplines of social, environmental and behavioral sciences. Mexico City and surrounding areas are used as the terrain in which the field work unfolds. The stories of life and customs in the affluent southern areas in contrast to the impoverished western settlements located at the bottom of Cerro Tlacoyaque provide a contextual background for the study, and is particularly relevant to explain certain urban patterns which were identified. The research essentially deals with food waste produced in residential dwellings. Although references of other types of waste are made throughout the work, the following chapters present a narrative predominantly related to food waste management.

Problem statement

Mexico is considered an emergent country with a strategic geopolitical dimension in Latin America. Since the 1970s progress has been made in many areas. According to FAO (2011), in the last 2 decades, Mexico features an increase in food security and significant decrease in food health issues by 73% between 1988 and 2006. [3] Food production is a fundamental embedded characteristic of Mexico's cultural identity serving as a 'linkage' between the rural and the urban (Tannerfeldt & Ljung, 2006: 35). There is indeed a connection between rural and urban areas at both domestic and economic levels. Rural life is to some extent preserved by urban activities which provide alternative income opportunities for rural/urban migrants. Over the past 50 years, Mexico City has hosted underemployed rural dwellers who are known to settle in peri-urban areas. In-land migration and the conditions of such rural dwellers have been well researched (Aguilar & Santos, 2011; Connelly, Roberts, & Zheng, 2011;

[3] The Food and Agriculture Organization of the United Nations (FAO) has a historical technical cooperation with Mexico. As a founding member since 1945, Mexico has benefited from 60 of the 170 projects developed worldwide. Among the ranges of projects developed over 60 years, are the "telefood activities" related to food production and treatment that is particularly fitting to the topic of this research. In 2005 a project directly related to worm farming of food waste was launched in *Texcoco, Estado de Mexico* located north of Mexico City.

Gilbert, 2009; Jones & Ward, 1998). This dissertation therefore, does not focus on these problems rather it focuses on the contextual conditions found in selected peripheral settlements and how they affect urban service procurement.

The link between the type of settlements and the level of access of waste management services is at first glance not only a problem of financial means, but also implies issues related to sanitary infrastructure procurement, the level of accessibility, mobility of residents and the relationship existing between the local community leaders and the local government bodies that operate among them. Waste collection is one of the first services required in a settlement. The lack of it has an immediate impact on the livelihood of residents regardless of tenure security arrangements and levels of formality or informality of the settlements.

Another aspect that characterizes Mexico on a scale that is more regional, is the size of its territory with respect of the population that it hosts. Notwithstanding a sustained decrease in the rate of Mexico's population growth in the 1970s, the demography of the population modified significantly. The 2008 demographic indicators from INEGI[4] show that in the next 25 years most of the population in Mexico will reach working age (Aguayo Quezada, 2008). This human capital presents an opportunity for development but also comes with real challenges in term of ensuring the health of a population that will enter a new aging era with a higher rate of life expectancy. OECD health data in 2010 shows that Mexico ranks low in terms of health spending as a share of GDP in comparison to other OECD countries. Mexico's total health expenditure represents 5.9% of Mexico's GDP and health care

[4] INEGI stands for *Instituto Nacional de Estadísticas y Geografía* and is dedicated to systematizing and divulging statistical and geographical data collected across the Mexican territory. Founded by Presidential decree in 1983, INEGI is the Mexican official statistical authority that publishes information regrouped in six thematic package: science and technology, demography and population, economy, environment, occupation and employment and society. As do other primary and secondary sources, this dissertation incorporates, compares, adapts and sometimes questions INEGI's statistical findings.

supply is currently low (OECD, 2011a, 2011b). This suggests that Mexico needs to prepare itself in regards to the kind of healthy and prosperous society it nurtures.

In Mexico City the problem of sanitation is not new. In fact, it is acknowledged in a number of historical documents and through more recent publications on waste water management (Cohen, Morrison, & Glenn, 1999), collection and waste disposal (Gutierrez Avedoy, 2006; Mora Reyes, 2004), informal waste collection (Medina, 2005), municipal solid waste source classification (Buenrostro, Bocco, & Bernache, 2001) and the difficulties local governments face in terms of regulation and governance (Cortinas, 2003). Food waste is of particular importance in the debates surrounding sustainable waste management as organic losses make for a considerable portion of what is disposed in landfill. The impact of food waste mixed with other discarded items has shifted from being a distinct ecological issue to a subject at the center of political and public attention. The amount of municipal solid waste to be collected, transported, separated and disposed of in many cities around the world has become a serious challenge for local governments.

In summary, the research identifies three main problematic themes:

(1) Recent debates on final disposal of solid waste have fueled environmental discourses due to uncertainties regarding the closing down of the city's main official landfill. Mexico City's waste management system remains mostly transfer-intensive and landfill based. Less attention is given to more effective treatment of the organic fraction that is estimated at 53% of the solid waste generated in large cities and little is known on how food waste can be successfully diverted at household levels.

(2) Data shortage at grass-root levels debilitates implementation processes. Uncertainty in food waste composition and source generation restrains urban amenity planning and urban service procurement programs.

(3) Environmental education shortcomings in local government influence the implementation of organized continuous and targeted efforts to guide public awareness. It relates specially to integrative and participatory initiatives that take into account local contextual knowledge. The challenges caused by political-administrative fragmentation and lack of resources are partial structural waste education impediments, socio-cultural determinants also play a role in the extent to which waste is produced at the source.

1.2 Research purpose statement

The overall intent of the research is to find a connection between the social and cultural organization of individuals, the built environment and food waste management. This is based on the idea that sustainable food waste management in cities requires a constellation of processes, which implies a dialectical action between a society, the built environment and waste management. One driving notion that guided the research was to reconcile the competing needs of society, food waste, the built environment and nature. The knowledge produced from the social context of waste is put forward in upcoming chapters with the purpose of examining the relevance of socially-based indicators to assess food waste issues in the urban environment. The focus is to discover how a tripartite dimension of assessment can be made.

In the particular context of Mexico much effort has been spent to establish a regulatory framework for the separation of food waste within the organic stream from the general solid waste fraction. However the difficulty in establishing household management guidelines as well as infrastructural requirements remains.

A critical approach to food waste practices which takes into account determinant features of a society must echo not only a health imperative of finding a sustained solution to food waste, but also an environmental commitment. Food, waste, people and space are intertwined in ways in which the nodes of connection may be better

explored by combining the views of sociologists, urban planners, civil engineers, and environmental psychologists to respond to issues related to the municipal solid waste (MSW) in the urban environment.

The main research strategy employs the information obtained from the field work to achieve the following objectives:

- To develop an instrument that integrates household indicators specific to food waste
- To provide knowledge to waste management practitioners, government officers and planners on how waste is produced in the domestic built environment
- To contribute to social change through the development of a participatory model for sustainable waste management practices in developing communities

Understanding how some social groups produce and manage food waste allows us to add another layer of characteristics to the current urban/environmental discussion in emerging economies. Moreover, there is a necessity to review the concept of solid waste management in the Mexican context. To do this people and organic waste must be situated in the nexus of household dynamics, providing therefore, another clarification and insight into the socio-spatial context of waste and its future perspective for Latin American communities.

Explorative research questions

Two sets of central research questions were raised. The first set of questions deals with the socio-spatial fabric of a society and the food waste predicament. The second set investigates urban planning and design implications based on proposed guidelines for better practice.

The first three questions are explorative by nature and aim at identifying the driving forces behind what connects the physical, and socio-cultural organization of Mexican residents and their food waste. The formulation of these questions implies reviewing the literature and triangulating findings from empirical work to connect identified features that may have an impact on environmental practices in Mexico City. They are formulated as followed:

RQ-1. What are the most significant features of the urban environment with regard to food waste management?

RQ-2. How do food waste disposal practices take place in residential dwellings?

RQ-3. What contextual determinants may impact the composition and volume of food waste at the source?

These questions were necessary to disentangle various facets incorporated into the urban environment in the context of Mexico. Focus was given to the condition of the built structure and the distribution of resources in the city. The questions center on social attributes and food waste. Such attributes incorporate constructs such as 'place attachment', 'community participation', the 'built environment', and 'household structure'. Established in a descriptive mode, these questions pursue facts about the relationship of Mexican residents within a specific urban context and the nature of the food waste produced. Moreover, given that differences in the constellation of social livelihoods are signaled from a diversity of sources it was necessary to address the relationship between groups and to point out the features of the environment in relation to those groups.

Normative research questions

The second central research question investigates urban planning and design implications based on proposed food waste management better practice criteria. These criteria emerge from the findings obtained from the first exploring segment.

The questions which call for a deductive approach are normative by nature. They aim at identifying ways to ameliorate the work process related to waste management and seek answers related to reflection and change. This endeavor involves the review of different planning mechanisms and operational frameworks at ground/local levels. The questions are formulated as followed:

RQ-4. What are the organizational changes needed for sustaining environmentally-sound practices in waste management?

RQ-5. How can better food waste management practices contribute positively to local urban planning and design?

1.3 Research design

Readers may perceive a qualitative tone in this dissertation. Much of it emerges from numerous conversations with local experts and observation protocols conducted over several field trips to Mexico City and its surroundings settlements. Another influencing force towards developing a qualitative approach is due to the nature of the literature available in Mexico. Both local primary and secondary sources draw heavily on qualitative social findings. In fact, the reflections on the development of the research context presented in Chapter 4 are not only retrieved from a collection of interpretative sources but also emerged from the field. Much of the work was conducted in the natural setting, thus the data was collected where the phenomena occur and through interaction with people, which is an inherent characteristic of qualitative research (Creswell, 2009). This 'up close and personal' interaction constitutes an important feature of this research and is detailed in the methodology chapter. Between 2007 and 2009, several field trips were conducted in Mexico. For instance, the exploration of the nature of food waste in residential dwellings required an interactive collaboration with participants. The number of exchanges between the researcher and participants varied between 7 to 15 days and included repeated telephone calls and visits.

It is important to note that in general the development of knowledge on Latin American cities has increased in the last five decades. The landscape of printed documents and electronic scientific journals reviewed reveal a substantial data on the historical, social and cultural development of Mexico. This data naturally pervades this work in a qualitative explorative form.

In contrast, specific data on food waste composition, as well as disposal trends and attitudes is scarce. Relevant data acquisition was obtained through techniques that were more quantitative in nature. Most of those tools accentuate the information obtained from a chosen purposive sample. The rationale behind choosing some quantitative measuring techniques is to explore an instrument that helps generate standard information on food waste composition and weight at household levels. There is insight to be gained from a descriptive analysis of the social characteristics of the group of individuals who participated in the study, in connection with the type of waste they produced and the physical urban context. The body of knowledge on the type of food losses produced is 'ground roots' raw data that may help paint a better picture of food waste composition and food waste habits.

Mixed method procedures are becoming familiar techniques in social and behavioral sciences (Creswell, 2009; Tashakkori & Teddlie, 2003). The problems addressed within those fields of study often present a complex structure and may require several layers of explanations. In this particular study, the combination of research techniques had the potential to both explore and explain the culture of waste management in Mexico. The data were collected "concurrently"(Creswell, 2003). Quantitative results are used primarily to assist in the interpretation from qualitative findings. This research favors simultaneity over sequentiality for pragmatic considerations and follows a research philosophy borrowed from action research principles. In short:

This research focuses on what works rather than preserving the intactness of the method. The lessons learned from conducting the empirical work in Mexico City are that flexibility and adaptation to change are necessary for understanding the unique sense of household interactions. This approach does not come without challenges both during its application and analysis. Critical issues noted are time-consumption, communication barriers, trust, accuracy of data and reproductivity of procedure.

1.4 Research particularities

Among the challenges faced during the four years of research were aspects of distance and remoteness that have influenced the procedures of data collection and have impacted the research calendar. In contrast the same spatial restrictions experienced repeatedly have broadened the scope of the literature review and allowed the incorporation of behavioral research lenses that were not originally planned in this work.

From its initial stages from 2007 until 2010, the research was conducted in three geographical settings: Germany, Mexico and Australia. In each continent, a particular research task was conducted. The journey began in Germany as the idea of exploring food waste management systems from a social viewpoint germinated through intensive exchanges with environmental engineers at the Department of Waste Management at the Bauhaus Universität- Weimar. It is not uncommon that the term journey is used as a metaphor to describe a PhD process, scholars such as Denholm and Evans warn us about it being a period of "promises as well as dead-ends, sheer joy and hard work" (Edwards, 2006: 6). Indeed many promises and expectations were raised in Colloquiums presented in 2007. My initial ideas about the ecological value of waste in urban areas evolved and changed as dead-ends were encountered in 2008. Over time, different avenues were explored and courses of action using graphs, timetables and mind-mapping were set. Germany is mostly where academic discussions took place and explanations were revealed. Inspiring conversations with my PhD fellows and the guidance of my supervisors triggered the intellectual effort behind this work. Chapter 7 for instance, proposes guidelines for better practice and

aimed at enhancing probabilities of success in settlement planning and design. The elements of critical thinking expressed in that chapter emerge from cross-disciplinary discussions with academic staff from engineering, social and planning disciplines. In addition the growing community of Latin American scholars in Weimar provided a rich learning and reflective platform to support the ideas proposed in the guidelines. In short, the period of research at the Bauhaus Universität-Weimar in Germany provided the supportive intellectual climate, sustained tracking of progress and the freedom to develop ideas autonomously.

In Mexico, much of the raw data was collected, the empirical work was conducted in two main stages: Stage one included an explorative exercise with local actors in 2007 followed by a second stage that concluded in 2010. Stage two incorporated field work which involved working with participants and includes an element of attention to culture and social norms, in an attempt to understand the unique sense of interaction in Mexico City and to do justice to the complex socio-spatial characteristics that pervade the central region of Mexico. The scale of Mexico City is one that has always been intimidating with a population of approximately eight million inhabitants at its core. Conducting empirical research under those circumstances required an approach that favored depth (i.e. a prolonged and sustained observation/interaction) over breadth (i.e. variety, dispersed interest). Lessons learned are revealed in detail in Part III, Methods and Results.

In Australia the data collected in Mexico was analyzed. From 2008 until 2010 the interpretation of the data was conducted mostly in Australia at the University of Sydney. During that time I was appointed visiting scholar at the Faculty of Architecture, Design and Planning and joined a group of scholars from the Environment Behaviour and Society (EBS) Research Group. The exchange of ideas on the interactions among people, culture and the urban environment helped shape the procedures for analyzing the data focusing on linking qualitative and quantitative

elements. In addition, a literature review primarily in English and with a focus on the Anglo-Saxon context was conducted on food and waste sociology. The research experience conducted in Australia was particularly constructive while exploring more about concepts related to learning by doing. Additionally, being exposed to different analytical models and software helped to identify the most appropriate tools for this research.

This dissertation features multiple language sources, therefore inherently deals with translation challenges as well as "conceptual equivalence" across Spanish, English and German. These issues are not ignored, in fact when faced with an interpretation dilemma, several possible definitions and synonyms were discussed in the quest to raise awareness of the different options of the meaning. A conscious decision was made to use the name of places, locations, colloquial expressions as well as institutions as much as possible in their original language. This is done with recognition of how different languages may convey different meanings to a phenomenon and may in fact construct different ways of perceiving it. Indeed Larkin et al. (2007) observe an increasing trend toward confronting issues of translation in research and suggest that failure to address the challenges in translation may be considered as a sign of weakness in study design. Given that the main data collection was conducted in Mexico, this research holds a substantial amount of information gathered in Spanish. Much effort was made to preserve the congruency of the raw body of data in Spanish and to provide as much as clarity as possible both in footnotes and in the appendix volume.

The multiple stages of the literature review are reflected throughout the entire body of the thesis. The search for information in printed documents was conducted partially in 2007 in Mexico and Germany, in 2009 in Mexico and in 2010 in Australia. Many of the references in Spanish provided a landscape of Mexico City and its surroundings. Most of the English literature was reviewed in Germany and Australia. The literature review conducted specifically on matters of sanitation and

the urban environment is mostly framed in a Post-Brundtland era. Since the Brundtland Commission Report in 1987, the concept of sustainable development has been widely interpreted and applied (Breheny, 1992; Hardoy, Mitlin, & Satterthwaite, 1992; Mitlin & Satterthwaite, 1996; Pugh, 2002). To those concerned with environmental issues, the idea of a sustainable development implies a long-term preservation of resources in times of global change. However, still today (2012), a broad range of concerns are raised around the concept of what is to be preserved and how should it be best preserved.

1.5 Research boundaries

A discussion about aspects of sustainable waste management is outside the scope of this work. However an acknowledgement is made about the concept of sustainable development in developing and developed communities as they are of a different nature. In developing communities environmental burdens are at hand and much more perceivable (McGranahan, Songsore, & Kjellén, 1996). Additionally there is clear evidence that not all countries have the same capacity to develop environmentally-sound policies and strategies to preserve our common future. The boundaries of this dissertation are situated within the domain of the urban environment i.e. cities and the problems of organic waste management in the domestic sphere. 'Sustainability' is used as an umbrella term that provides a conceptual framework and helps situate the work. Additionally, political and economic considerations at global and regional scales are not included, nor are considered technical aspects of food waste treatment and final disposal.

Part of the empirical work covers the domestic sphere and focuses specially on a limited number of households. The reduced number of monitored families hamper the possibility of general observations. The sample is not representative enough of any of the boroughs of Mexico City. Broader explanations rely on analysis based on further exchanges with experts and local know-how. The families who participated in

the study were and remain dynamic. They expand, reduce, change and transform by internal life cycle processes but also by other external factors. During the time when the empirical work was conducted and the results were processed some of the household transformed and changed. Some family grew in size, buildings were modified and new occupations were taken. The analysis reflects a research interval from 2009-2011.

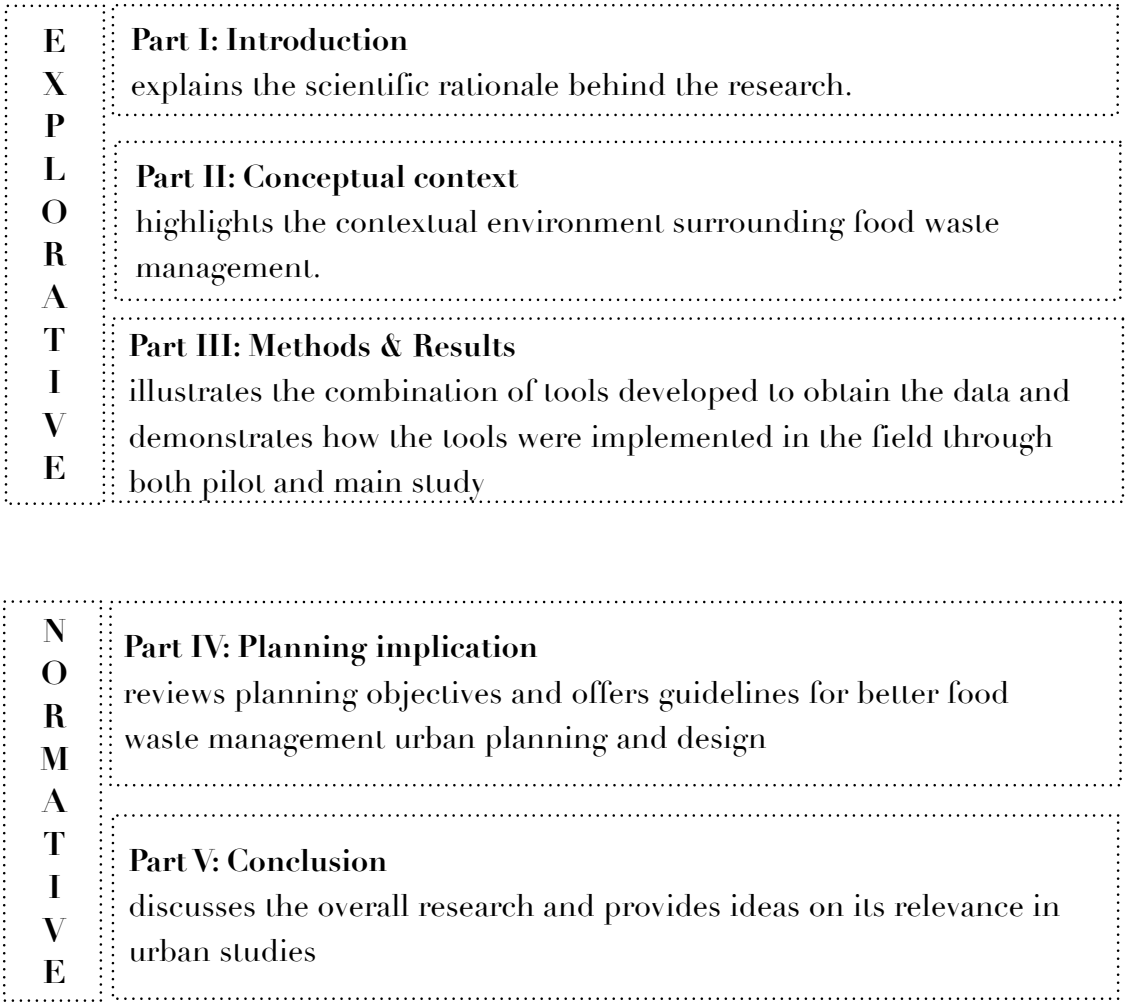

Figure 1. Thesis structure

As illustrated in Figure 1, the thesis contains five distinctive parts. The introductory segment explains the scientific rationale of the research. In it, readers will find an abstract representation of the structure of the thesis along with explorative and normative research questions. One set of questions investigates combined and

correlated phenomena related to food waste issues, the other inquires about the conditions for a new type of normative standard in local government. Additionally, it explains some of the particularities that may have influenced the research findings and overall structure.

The second part offers an explorative narrative spread through three chapters. The opening chapter, itemized as Chapter 2, provides multi-scale links on selected waste constructs. The discussion centers on the knowledge of solid waste management and focuses on multidisciplinary modus operandi emerging from findings from urban sociologists and environmental scientists. It is important to note that this chapter does not offer a lengthy discussion on theories or historical precedents and philosophical explanations on society in the built environment. Instead it builds arguments based on practice oriented knowledge and offers explanations based on integrating processes. Chapter 3 conceptualizes food waste. It includes a working definition of what is considered food waste and/or losses and a categorization of food waste. The necessity to have a clear terminology in waste studies helps us to identify the nuances of certain terms which also have policies and programs implications. From there it is possible to explore how the different terminologies are used in the scientific world and the boundaries of the meaning of food waste in this dissertation. Chapter 4 presents the context of Mexico City in which waste management unfolds, it summarizes the national state of waste management and highlights critical issues regarding the growth of the population in urban areas and the multiple difficulties that local authorities face with waste collection, transport, and final disposal.

Part III, which includes Chapters 5 and 6, provides a detailed description of the methodological strategy used in the research and the research findings. The study of how food waste is produced in residential dwellings in Mexico City required an instrument that integrated the narratives of locals, and allowed them to take on a

more active role in the generation of data. The methodological strategy developed for the purpose of the research integrated a variety of indicators regrouped into a tripartite data collection instrument. The instrument developed for the purpose of this study includes a household based questionnaire, which offered clues on socio-cultural determinants, behavioral factors and the urban context of the studied areas. A food waste diary brought forward the food waste composition and daily practices of waste storage, and a weighing record provided the weight and volume of food waste. Chapter 5 also signals the particularities of pilot studies conducted in distinct geographical settings and offers reflections on the continual improvement of the instrument developed over time. Chapter 6 presents the results. It offers an overview of 27 fieldwork cases selected in Mexico City's Metropolitan Area (MCMA) and three cases located in Jiutepec in the State of Morelos. The cases were grouped into less and more affluent circumstances, taking into account selected structural differences such as housing characteristics and access to urban services. Chapter 6 presents further information about the groups of individuals who participated in the main study conducted in *México Distrito Federal, Estado de México* and *Jiutepec*. This chapter addresses some of the key features of the built environment in relation to waste habits. It signals the contrast between the physical background and the manner in which the context influences household practices and everyday life in Mexico.

In Part IV a normative tone is distinctively perceivable as planning implications are revealed. A distinction is made between the strategies envisioned in the Mexico Metropolitan area and the instrumentations and actions that result. Chapter 7 examines aspects of food waste management that can be associated or should be considered in urban design and planning. Seven criteria for better practice are put forward.

To pinpoint data on waste it is necessary to search for specific literature in the environmental science field, in technical handbooks or government reports. The literature on food waste emerges for the most part from the biology or engineering field. Food waste discussions in urban study literature are limited. Even more limited are reflections on how the urban environment influences food waste management in Mexico. Indeed, despite significant efforts that have been made in assessing the composition and weight of solid waste in Mexico's metropolitan area, little is known about the type of food waste produced in residential dwellings. This dissertation offers a first distillation into the nature of food waste in different household structures in the Mexican capital and surrounding settlements. Another added value is the influence model proposed to explain the interaction of the urban physical, built and socio-cultural on food waste output from less affluent and more affluent groups.

Scientific research gap

There is simply not enough data on 'food waste composition at the source' in peripheral settlements of Mexico City and little is known about how individuals dispose of their organic waste in settlements with limited urban service procurement. In other words, the contextual dimension of the problems associated with organic waste is not systematically researched in Mexico. Little is known about what type of food waste is produced at household levels and most importantly how and what are the factors influencing its production, and separation at the source as well as city management. Data shortage in this area and uncertainty of source generation debilitate implementation processes. It seems therefore important to contribute to strengthening the existing body of knowledge on food waste in Mexico.

There is also a gap in interdisciplinary knowledge to better grasp organic waste issues in growing urban centers. More attention should be given to the integration of different layers of explanations including those originating from a socio-spatial

perspective. This research gap is not only applicable to the Mexican context but is also relevant to other Latin American cities. This lack of locally relevant information contributes to the disruption of urban functions and the application of foreign models that may not be fully adequate to local contexts.

More particularly there is a gap in the integration of knowledge between waste management and urban planning when one examines sanitary implementation discourses. The separation of these two fields contributes to uncoordinated effort to understand and address other urban thematics such as health, the natural environment in cities and livelihood issues. A failure to narrow the links between waste management and urban planning is perceivable for instance when one observes current waste collection and urban design disparities in large Latin American cities. One reason for this is a lumbering palliative approach to remove waste rather than placing emphasis on the importance of collaborative contributions for prevention.

This dissertation attempts to responds to these gaps. The next chapter discusses selected constructs from global, national, local and individual scales of waste and proposes a conceptual framework that allows a more comprehensive assessment of critical issues in waste management practices. The growing concern for waste solutions adequate to local needs is based on the evidence that top down solutions often fail to take into account the differentiated realities at grass-root levels. Waste issues viewed from a multiple scale perspective imply a juxtaposition of processes which offers opportunities for urban and environmental scholars and field practitioners to combine their effort into more integrated knowledge that can contribute to solving urban transformation issues.

2. Multi-scalar perspective of waste

Chapter 2 presents existing links between global, national, local and individual perspectives of waste and proposes a guiding model based on the reviewed literature. The ideas discussed emerge mostly from the environmental and social sciences with a particular focus on infrastructure and environmental behavior. The urban context frames this chapter and provides a platform within which the ideas revealed are further developed. This chapter brings together concepts that may at first glance appear divergent; this is done with the goal of encouraging interdisciplinary inquiries.

2.1 The urban frame of waste studies

The study of waste from an urban perspective is increasingly becoming one that demands multi-scalar approaches to capture different circumstances occurring at different levels. In the 1920s, urban environments were signaled as living systems similar to nature and governed by different forces. Natural areas were compared to areas of population segregation, where there is competition between different groups for the same physical space (Park, Burgess, & McKenzie, 1925). The concept of urban ecology which emerged from the natural sciences domain was put forward to demonstrate that humans living in cities had similar interactions with nature as plants in their own ecosystem (Collins, et al., 2000; Marcotullio, Piracha, & King, 2003; Sukopp & Wittig, 1998). The idea that cities were ecosystems provided the possibility of re-examining concentrated areas and adding other components to the notion of what is urban. The central reflection is that settlements (regions, cities, neighborhoods) are considered as systems. Urban ecosystems are habitats in which it is necessary to progressively increase a positive synergy of recycling in order to balance life in the system. This implies strategic feedback loop actions within cities (Barton, Grant, & Guise, 2003). These actions may support the resilience of cities by minimizing direct impacts (e.g. landscape damage and habitat losses) and secondary impacts (e.g. travel patterns and accessibility). In short, people's activities and relationships combined with the natural environment form an integrated life cycle that needs to be considered within overarching sustainability principles.

These considerations bring forward the particular place that waste occupies in our society. Waste is intimately related to our consumption patterns, which makes it a local and individual phenomenon. A trend attached particularly to the 21st century is the growing increase in the amount of "post-consumer waste" (Clapp, 2002). Common examples are goods that are hardly suitable for reuse, recycling or composting, they are designed to be thrown away after one use and they are present a particular challenge in growing economies. "Waste management is merely a

reaction to waste" (Pongrácz 2002: 20). In most communities, waste practitioners simply do their best to put it out of sight. As seen in Figure 2-1, the ability to recycle both organic and non-organic waste enables cities to conserve resources. The schematic model shows the input and output of goods based on the idea of minimizing both global and local impacts. When food, energy and water are digested and recycled, cities have the opportunity to minimize their emission levels as well as to improve their local environmental conditions (quality of air, biodiversity, and better land cover, among other benefits).

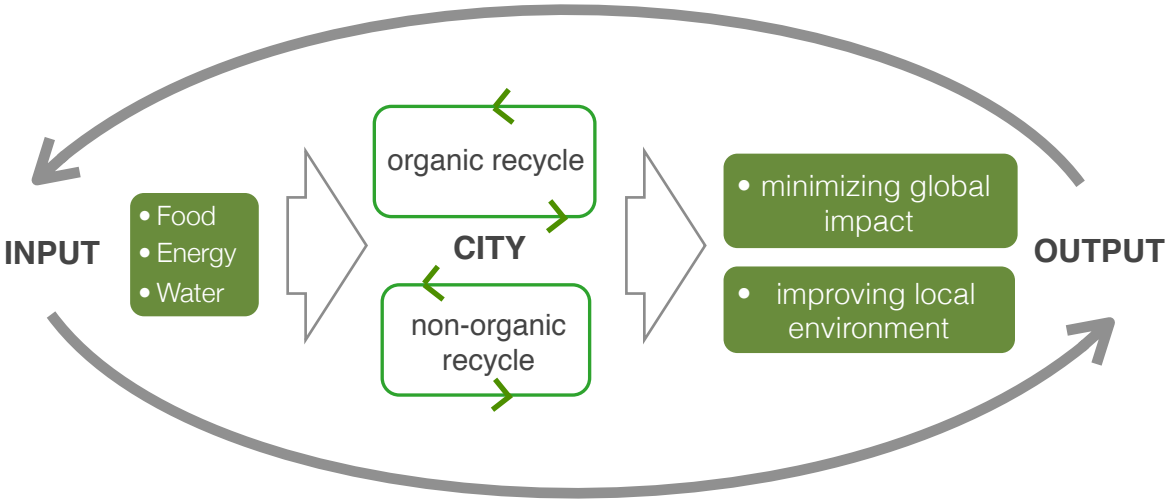

Figure 2-1 Schematic input and output of goods in cities

In recent years, the tone and diversity of environmental forums suggests an increasing need for interdisciplinary modes of assessment. Waste issues viewed from a multiple-scale-perspective imply a juxtaposition of processes that require attention from different scientific fields. The social issues related to poor waste management are increasingly reviewed and forecasted in international forums, forcing us to reexamine our interpretation of knowledge in that field. 'People-centered' knowledge offers an added value to technical and biological facts. This distinction addresses how urban systems react to waste and provides a causal and temporal assessment that enable decision makers and practitioners with implementations tools that are more robust. Indeed, much of what we know about the technical aspects of wastewater treatment, reuse and filtration as well as decentralized solid waste

management systems has been produced in the environmental science field (Bidlingmaier, 1990; Bilitewski, Härdtkem, & Marek, 1994; Tchobanoglous, Theisen, & Vigil, 1993). Approximations that are more passive are left to those concerned about the multiple and contrasting realities of waste production and its treatment in the urban sphere. These contributions allow qualitative interpretations based on practices and events that occur in situ, thereby highlighting central context centered phenomena in all their social and spatial complexity.

2.2 Global, national, local and individual constructs

Selected constructs at a global level

Discourses on waste in the urban environment can be unpacked into four distinctive scales or levels within which specific constructs prevail and interconnect. As cities are becoming more urban, waste discourses consider the role of recycling in macro contexts as well as questions of globalization and consumption. The idea of recovery of raw material from waste stems not only from beliefs emerging from the nature conservation field, but also from economic interests from advanced communities as growing demands for primary materials require innovative approaches to use waste as a resource.

Figure 2-2 Selected waste constructs at a global scale

Figure 2-2 illustrates selected constructs that pervade at a global scale. The recognition of the economical and environmental benefits of recycling has been put forward since the 1970s. A growing interest in recycling was observed in the 1980s and through the 1990s when landfill shortages began to occur. Questions related to the profitability of reuse items, the social cost of recycling (Bruvoll & Nyborg, 2004), the potential to reduce health risks and pollution as well as broader considerations of cost benefits of recycling in the waste industry were foregrounded. These questions were raised due to an interest in reducing the need for landfilling and for the development of alternative technologies. Recycling was not only discussed in the applied sciences but has been also at the forefront of studies in the environmental behavioral discipline (Barr, 2002; Barr, Gilg, & Ford, 2001b). Scholars brought their attention to the role of communities and individuals with regard to sustainable waste practices through early studies on the characteristics of recyclers (Coggins, 1994; Oskamp, et al., 1991). Barr et al. found that older females with a certain knowledge on policy instruments had better recycling habits (2001a). Further, three sets of variables were associated with recycling behaviors: 1) environmental values - it was found that those who value the environment for what its worth are more likely to recycle; 2) situational factors or contextual determinants - these may be socio-demographic, physical or experienced-based and lastly; 3) psychological factors - related to the personal traits of individuals and their personal responsibility towards the environment (Barr, et al., 2001a). Despite the fact that environmental, contextual and psychological factors were determined and have been widely discussed throughout the 20th century, there is less understanding about the degree to which these characteristics influence recycling. Moreover, studies on other types of waste behavior such as public littering and illegal dumping are scattered especially in emergent economies.

The global complexity of waste was highlighted in 2005 by the Commission of the European Communities which stated in its introductory chapter "waste is an environmental, social and economic challenge for Europeans" (Commission of the

European Communities, 2005:3). The concern expressed by policy makers was the negative perception of waste among Europeans, as well as unsustainable trends in waste generation and unclear regulations. They suggested then - and many argue that it is still the case today (2012) that there is a need for multilevel solution-based approaches in Europe. In other words, different types of responses and instruments are required to tackle intertwining problems from implementation challenges in waste management to unsustainable trends and behavior. Despite the fact that in the last 30 years waste has been a central concern of EU environmental policy, consumption and waste production remain a challenge in Europe. Approximately one kilogram per person per day is produced across the continent each year. It makes a total of 2,000 million Mg. of waste, which needs to be collected, treated and disposed of somewhere in or outside the continent (European Communities,1999).

In North America, key environmental concerns are industrial pollution and waste. The amount of hazardous and non hazardous waste, which encompasses a range of unwanted substances being generated, is significant. The commission for Environmental Protection, which addresses those issues in the region, reports a total of 34.8 million Mg. of hazardous waste generated by the United States in 2005 mostly in the form of liquid waste. Canada's annual generation is about 6 million Mg. and in Mexico a production of 8 million Mg. of hazardous waste is commonly cited in official documents (Commission for Environmental Cooperation, 2007).

The recognition that waste challenges occur at various levels is particularly clear when we look at the conglomeration of environmental challenges of Mexico. Firstly there is the issue of waste treatment and disposal, such as mismanaged landfills, waste collection and recovery limitations; which continue to concern waste management practitioners (Mora Reyes, 2004). Secondly, there is evidence of unclear legal framework and policies, which require more input within the political and legal arena (Cortinas, 2003). Thirdly, the infrastructure challenges particularly at local

levels make it difficult to find continuity in environmental progress and lastly, there are social difficulties experienced by those living in close proximity to waste (Moore, 2006). At the end of the 1990's scholars recognized the need to look at waste from wider viewpoints (Coleman, 1998; Murray, 1999; O'Brien, 1999). The problems that environmental authorities faced around the world were not simply a matter of failed governance. More knowledge was required on how we produce waste, why we produce it as we do, and how to better deal with hostilities resulting from implementing waste management strategies.

At the risk of oversimplifying complex environmental debates over several decades, the previous reconstruction suggests why a global perspective of waste is particularly fitting, and even more so at a time when climate change debates in terms of net fluxes of greenhouse gases from various combinations of options are used for the management of MSW (Smith, et al., 2001). Since the 1980s ecological debates fostered worldwide agreements on toxic and hazardous residue. Waste was no longer a national concern but transcended frontiers to find itself as Murray puts it "at the hub of environmental argument" (1999: 2). At the start of the second decade of the 21st century, the issues surrounding managing waste in cities around the world imply a permanent struggle of social, environmental, economic and political sphere at both micro and macro scales. The volume and nature of waste we discard in different parts of the world creates patterns of waste flow, which require governance at international levels.

Selected constructs at a national level

At a national level, there are distinctive waste discourses. Figure 2-3 shows some dominant themes in developing as well as in industrialized economies. The difference between the manner in which waste is conceptualized and managed in the developing world and in developed communities is determined to some extent in their varied socio-economic realities. In high-income countries, discussions about

growing consumption and the challenges existing regarding its sustainable management continue to pervade environmental proposals. Some of the challenges faced by industrialized communities are to maintain their competitive and diversified waste management systems while sustaining growth and complying with environmental regulatory frameworks. This is made evident through discourses which incorporate notions of sustainable economic growth and resources supplies (Meadows, et al.,1972); consumption and waste management technology (Baudrillard, 1970), as well as the economics of waste. On that note, it is now stressed that the cycle economy of waste is one that no longer considers waste as an end product rather as a secondary material. Since 1997, Germany's economy and waste management has been based on a closed loop system in which the government and producers must share the responsibility for managing waste. Examples such as the *Producer Pay Principles* and the *German Packaging Ordinance* (last updated in 2009) (Pongrácz, 2009; UNSD, 2007) are some of the regulatory approaches set up to tackle a growing waste production in Europe (UNSD, 2009).

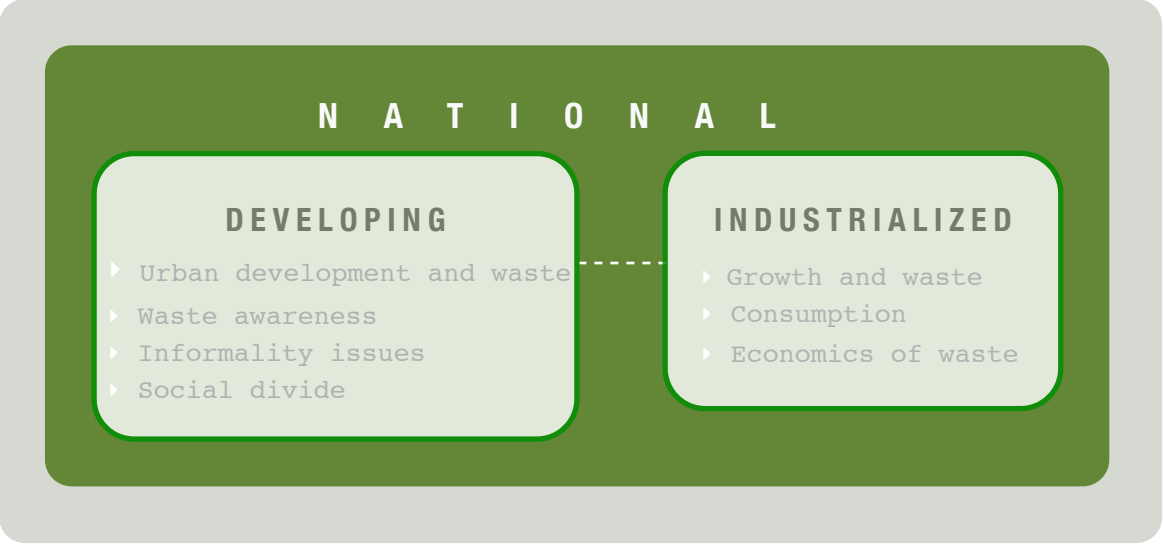

Figure 2-3 Selected waste constructs at a national scale

There is proven substantial variation in the composition of municipal solid waste (MSW) as well as in the rate at which waste is generated at national scales. In the 1980s average rates of waste production in the developing world were estimated as 0.4 to 0.6 kg/d.ca, compared to generation rate of 0.8 to 1.8 kg/d.ca in more affluent countries (Cointreau, 1982). A report on MSW in least developed Asian countries shows a generation per day per capita between 0.4 - 0.55 kg in Bangladesh (Alamgir, et al., 2005). Waste generation rate in Mexico has appeared to increase continuously. The generation per capita of 0.90kg/day reported in 2004 is projected to 1.01Kg/d.ca in 2015 (CONAPO, 2003; Gutiérrez Avedoy, 2006). According to OECD environmental data, The United States of America features the highest generation rate per capita in the world with over 2.0 kg/d.ca in 2007 (UNSD, 2009). Solid waste generation in Australia between 2002 and 2003 was estimated to be 1.6 kg/d.ca (Productivity Commission, 2006), ranking Australia second in the list of most wasteful countries in the developed world, along with Denmark, Germany and Canada. The OECD country average for 2006 was 560 kg per person per year (OECD, 2011: 52).

The composition of municipal solid waste produced in developing nations is known to have a higher level of moisture and fiber (about 2-3 time greater), a larger amount of organic matter (Bidlingmaier, 2001), larger quantities of dust and smaller particles than the waste produced in industrialized countries (Zerbock, 2003). Another overall observation is that the waste density is 2 to 3 times greater in economically challenged countries than that is for developed nations. Such distinctions affect directly the discourse of waste management practitioners when looking at the challenges faced as well as the opportunities that arise from the waste composition.

In low-income countries debates on waste have a tendency to focus on issues of development and socio-economical challenges associated of integrated waste management schemes. One theme that pervades is the question of informality raised by many authors as listed by Quiroga Pachecho (2011). In 1995, Van de Klundert and

Ladinois (1995), when reviewing the state of the art and need-assessment in municipal solid waste management in developing countries, identified different stakeholders: the municipal governments, the formal private sector, the informal private sector, community based organizations and non-governmental organizations. Ghersi in his essay on informal economy in Latin America (1997), identifies informality in many elements that sustain urban systems such as the economy, construction and housing, commerce, industry and services. He argues that informality is a product of legal and institutional shortcomings (Ghersi, 1997). Wehenpohl et al. (2007) as well as other authors named by Quiroga Pacheco (2011) acknowledge the character and role of informal workers in waste management in Mexico. They report three main bodies of *pepenadores* (informal workers/ waste collectors scavengers/ waste pickers) responsible for collecting household waste produced in Mexico City. These organizations feature a co-operative organization or civil association institutional format, neither taxed nor monitored by local authorities with no employees. They operate however, under a classic business model, presenting a hierarchical structure similar to any formal corporation. It is estimated that close to 30,000 volunteers work as *pepenadores* in Mexico City. Understandably, questions of equity and justice are raised in debates related to the rights of *pepenadores*, their social polarization and geographical marginalization (Mora Reyes, 2004).

Another characteristic particular to the socio-economic reality of developing countries is social stratification and therefore different urban realities. There are clear differences in ways that space and opportunities are produced and these divisions are reflected in the waste composition as well as the level of procurement of adequate infrastructure and the quality of the provision of waste management services. It is not uncommon to observe a distinction between "poor", "medium" and "high" waste generation, when quantifying the volume of waste generated in these cities. In other words the waste generation is calculated separately based on assumptions of different lifestyle, education and consumption patterns. For

instance, local statistics feature a production of 271 Mg. of municipal solid waste (MSW) produced in the municipality of Jiutepec located south of Mexico City (Thesis Consulting, 2005). These estimations were further categorized into three main socio-economical strata to calculate the waste generation in different types of households. Waste composition studies conducted in the field revealed that Jiutepec's low income sector (which represents 78% of the local population with 142.338 inhabitants) generates daily 45.62 Mg. The medium income sector produces daily 15.45 Mg. and the high income sector features a daily generation of 16.67 Mg. (Thesis Consulting, 2005). Traditionally, the assumption is that lower and medium income groups produce more organic waste as opposed to those with higher income level, which generate more recyclable goods such as paper and plastic. In recent years, however these assumptions have been contested by those who have identified a shift in the composition of waste in transition economies.

Another particularity at a national scale is the legal framework for distinguishing between different types of waste. Waste definitions vary between nations, therefore the emergence of any form of regulation needs to be national and context based. In the German Waste Act of August 1993 waste is defined as "a portable object that has been abandoned by the owner" and also as an "orderly disposal garbage" (Bilitewski et al., 1994: 21). The Framework Directive on Waste in the United Kingdom states that waste is a substance and/or object that is discarded by its owners. This statement is followed by 16 waste categories that are currently in force (Porteous, 2000). The Mexican's view on waste, expressed in the General Waste Amendment of October 2003, refers to a material or product that owners or holders discard, which can be found in a solid or semi-solid state, as well as liquid or gas in a container or thrown away and can be revalued, treated or disposed of according to specific regulations (Congreso General de los Estados Unidos Mexicanos, 2003). These differences in the etymology of waste influence its assessment and practice.

Selected constructs at a local level

There is a growing concern to provide waste solutions adequate and appropriate to local needs. This interest is based on the evidence that top down solutions often fail to take into account different realities between the population that is being served, the conditions of the urban context and the interest of stakeholders engaged in the economy of waste systems and facilities. Figure 2-4 shows selected constructs that pervade at a local scale. Waste discussions that deal with the complex structure of municipal waste management are generally case sensitive as the issues vary upon locations.

Figure 2-4 Selected waste constructs at a local scale

Constructs such as sustained infrastructure, education and participation as well as historical concerns related with health and safety prevail in local waste discourses Bernstein, 2004; Cotton, Sohail, & Tayler, 1998; Solheim, Faupel, & Bailey, 1997). This may be related to the fact that household waste remains the most challenging type of waste to be handled at municipal levels (White, Franke, & Hindle, 1999). While the question of participation in the forms of stakeholder contribution, public activities, community engagement is raised frequently in current waste publications (Bernstein, 2004), the attention to waste education is less perceivable and seems to be focused on particular social groups. For this reason, a particular attention was given to action-based waste education practices.

Evaluation reports on waste education programs provide an informative picture of the scope of environmental education. Exchange with local practitioners confirmed a lack of continuity in waste education programs as they are often linked to local political agendas. In the 1970's William Bill Stapp et al., who suggested early definitions for environmental education (1969), put forward two concepts in regard to solid waste management in community-based educational program:

- Concept 1. Awareness and knowledge
  Programs on waste education must increase awareness and knowledge about solid waste management as well as trigger positive attitudes and motivate environmentally sound actions

- Concept 2. Continuity and progression
  Programs on waste education must have continuity and must progress in ways that the knowledge developed on one level is implemented and expanded in subsequents levels (Stapp, 1976)

Years later Shapeck suggested that local authorities may often collect insufficient data to improve the quality of their waste education programs (1993). McKeown notes three main factors influencing educational plans: special interest of stakeholders, knowledge of a small sector of consumers and intuition (2006). This suggests that education-based implementation may not always be compatible with current sociological patterns. The Environment Protection Authorities of New South Wales recognized that waste education guiding principles needed to evolve as communities' understanding on the scope and magnitude of waste issues increase (EPA, 1996). Over the past three decades, education strategies are taken into account within local policies however, there is no clear picture to date (2012) on how waste education progresses in this changing economy.

Historically, health and safety have been major concerns in waste management as they intertwine with sanitation issues at local levels. Contaminated water supplies are known to contribute to diseases (WHO, 2011). Accounts of epidemiological episodes worldwide stretch from the early 1500s in Europe and continue to cause

human threats in different communities. George who exposed the current state of sanitation in the UK and India, highlighted in her book some critical statements made by the UN Development Program and other authors "2.6 billion people don't have sanitation" (UNDP, 2006), "four in ten people in the world have no toilet" (George, 2008:2) "bad sanitation is linked to respiratory infections, malnutrition, malaria and worm infections (George 2008: 273). Human health impacts caused by sanitation deficiencies are more evident in developing countries and selected intertwining risk factors are:

- Drinking water as medium to transmit diseases
- Lack of services (i.e. solid waste management, access to safe water, use of adequate sanitation)
- Failure to plan, design and operate water resources based on the principles of integrated water resources management (Fewtrell et al., 2007)

It is necessary to stress the importance of the meaningfulness of territories at a local level. These territories evolve and transform based on the interaction of the local with the national and the global (Cox, 1997; Ward, 2004).

Selected constructs at an individual level

A number of studies examine how individuals produce waste and their disposition towards the idea of waste. Figure 2-5 shows selected constructs associated with the individual scale of waste. Studies related to the reason for waste production or the manner in which waste is produced vary in their approximations, however there are common characteristics that unify them. They focus on individuals' waste behavior, habits and even emotional commitment to waste. For instance, Hawkins' book *The Ethic of Waste* (2006) evokes a moral association between self and waste where she speaks of overflowing bin, dancing plastic bags and empty bottles in ethical terms. Hawkins' exploration of waste is phenomenological rather than ecological (Humpery, 2007; McDonald, 2006). This distinction singularizes her ideas on waste

habits as she focuses her attention on cultural and material practices and forms of rules.

Figure 2-5 Selected waste constructs at an individual scale

Behavioral scientists who examine habits of waste production, focus mostly on determinants affecting waste behavior and attitudes toward household waste management (Barr, et al., 2001b; De Young, 1986; Thompson, 1979; Vining & Ebreo, 1990). De Young's research, for instance, centers on people's commitment to environmentally responsible behavior. He argues that satisfaction in behaving in an environmentally responsible manner (such as recycling) derives from everyday activities that can make a difference in the environment over a long term period (De Young, 1986). Barr's research, on the other hand, revolves around environmental lifestyles such as household waste reduction, reuse and recycling. He points out that "attitudes towards reuse and reduction are values and concern based" (Barr, et al., 2001b: 79).

2.3 Multi-scalar perspective of waste

The socio-spatial perspective of waste centers its attention on the development, structure and function of societies dealing with waste. Jean Baudrillard's contribution to contemporary sociology with *The Consumer Society: Myths and Structures* (1970) is a pioneer reference of modern society and waste. This book

commonly classified in the domain of consumption theory, analyses the processes by which consumption takes place in post-modern societies; however, Baudrillard (1970) makes arguments associated with modern wasteful society, connecting therefore contemporary waste issues with the make-up of societies. Following his lead, other authors started focusing their work on customs, traditions and waste (Thompson, 1979). The sociology of waste is not new and has gained importance over years as changes in habits, behavior and public participation as well as awareness are considered as important as technical aspects of waste management. The social context of waste was more recently discussed in Edmonton, Canada in 2011. It followed pioneer efforts to expose social implications of waste in 2005 and 2008. The conference was organized by the Edmonton Waste Management Centre of Excellence and focused on responding to a growing need for theorizing waste. Researchers and practitioners from multiple disciplines came together to discuss issues related to the social forces affecting waste management, urban settings and waste economics. "Waste is a social problem" write, Huddart-Kennedy and Krogman, an issue that can be viewed across layers of worldwide related economies, lifestyle and routine and interpersonal desire (2005). The recent discourse in the social realm echoes O'Brien's argument on the lack of waste studies in the contemporary sociological sphere (1999). In his view, what we know about the sociology of waste is still limited and attempts to fill in that gap would be a worthily endeavor.

At the end of the 20th century, scholars like Peterson and Coleman advanced the idea that solving waste issues may not only require solutions associated with the infrastructure and engineering (Coleman, 1998; Peterson, Wunder, & Mueller, 1999). According to them, the formulation of opinions about the way societies could best manage their waste requires a more passive approach; one that looks at different outcomes based on understanding patterns of life in a changing urban environment and recognizing multi-layered sociological dimensions affecting waste issues. The themes central to a passive approach of waste are broad. Over the last 30 years the

body of work produced has increased substantially. Subjects vary from recycling trends (Derksen & Gartrell, 1993) to issues of informalities (Bartone and Bernstein, 1993), consumption patterns and all other ideas associated to the general communal context in which waste habits generate.

The model of a multi-scalar discourse on waste suggests four distinctive dimensions explored to obtain a comprehensive understanding of selected themes recurrent in the literature. [1] A multi-scalar approach inherently deals with overlapping layers of a system. Here, *scale* refers to the multiple dimensions of the context in which waste is produced and processed i.e. local, municipal, regional, national, and global. Figure 2-6 regroups the different components previously discussed in an integrated model that connects the global to the individual.

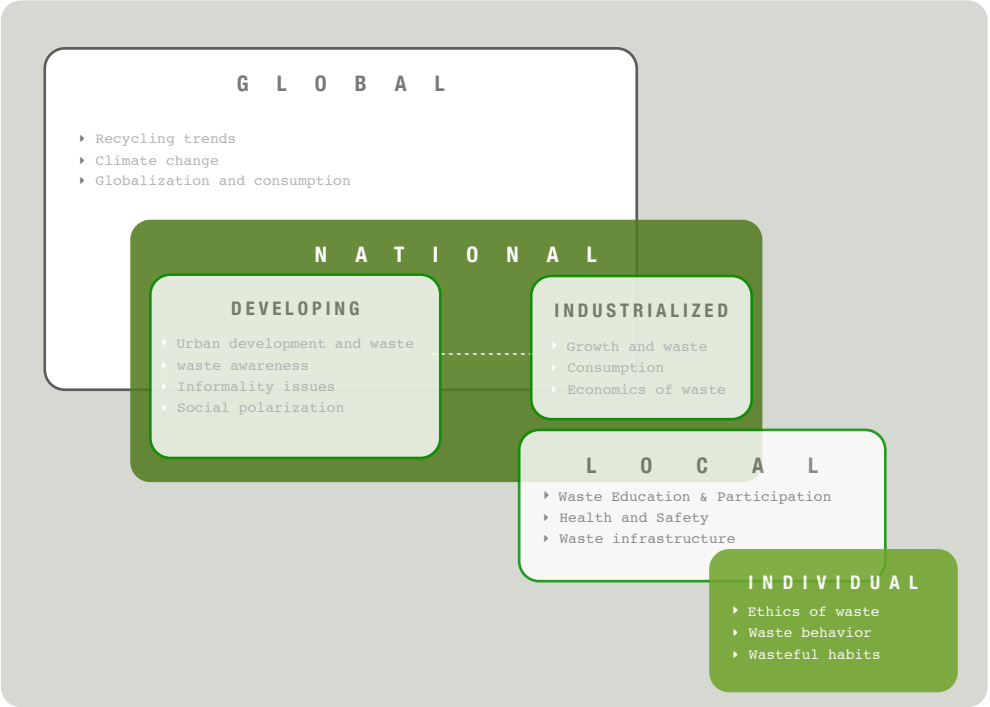

Figure 2-6 Model of multi-scalar perspective of waste

[1] The proposal of overlapping global, national and local perspectives to identify environmental clusters in contemporary waste discourses is not new. This approach stems from the rhetoric collective thinking. Other advocates of multi-scale approaches include Massey (1992), Murray (1999), Corning (2000) and Fagan (2003).

The question of scale, which is particularly relevant to situate waste practices in the case of Mexico, is not a new one. Fagan insists that "while we can see waste as a global fluid, with risk and profitability associated with its movement, at the same time we also need to conceptualize it as an extremely localized phenomenon" (Fagan, 2003: 71). Fagan further suggests viewing waste systems as a "complex global, national, local and individual set of processes" (2003: 67). Solid waste is tied to different particular areas as it emerges from a local sphere composed by households, commercial establishments and institutions. Considering waste discourses from local to global is central to address critical issues in waste management practices. Corning suggests considering both 'wholes' and 'parts' and their interaction at different scales when looking at the causal processes (2000: 147). A relevant example is the recognition that wider/global environmental consequences are linked with micro/local waste management implementations. This is particularly true for levels of greenhouse gases produced from both less and more developing countries which affect the planet at large. As it appears very difficult to reduce waste production at national levels, the global risk associated with all waste streams represents a major challenge today. Murray's reflection in 1999 remains still true today (2012); waste takes a central role in any contemporary environmental argument. Moreover, waste management decisions, policies, implementations and practices or lack thereof in one part of the world affect other parts of the world. In consequence, a multi-scalar idea allows the integration of wider concerns; it extends the degree of visibility of the problem of waste and allows a range of explanations stretching from the local to the global sphere.

The approach outlined encourages multi-disciplinary inquiries. The opportunities for planners, researchers, developers and environmental practitioners to collaborate and combine their efforts towards sustainable waste management are supported by a growing body of interdisciplinary discourse. The underlying idea is that cooperation

may often lead to the extension of skills or to a new way of thinking that may be better suited to population needs at large. This is evident when observing how local infrastructure procurement requires the involvement of the communities, as conventional top down approaches of infrastructure supply can no longer meet the demands of a growing urban population in developing countries. Discourses along these lines refer to learning more about community participation and empowerment as well as the underlying role of both formal and informal organizations in the procurement of water supply, sanitation and solid waste collection. These discourses take place at multi-disciplinary levels (i.e. policy making, development studies and infrastructure procurement) where the concerns for the social relations surrounding waste take a more dominant role.

In this study, a multi-scalar approach towards food waste management takes into account the following principles:
(1) Non-linear dynamic thinking that requires cross-disciplinary and interactive consciousness.
(2) Food waste management appraisal that calls for cooperative modus operandi based on combined cultural, spatial and structural considerations. The aggregation of different indicator components help articulate and explain locally rooted phenomena (i.e. waste behaviors and environmental attitudes and beliefs) that may be overlooked in prevailing waste management systems.

3. Conceptualizing food waste and its impact in the urban environment

Chapter 3 conceptualizes food waste and investigates how the term is understood and applied with regard to waste management in the urban environment. It offers some clarifications on common denominations of food waste and presents a categorization that was applied in the empirical phase of the research. This chapter highlights some aspects of food waste emission and environmental impact at global and local levels. It also deals with the institutional framework of food waste. Two criteria are proposed: one situates food waste within the broader household waste framework, the other proposes food waste diverting mechanisms at local levels.

3.1 The concern of food waste in the urban environment

Food waste occurs at all stages of the life cycle of food from the moment it is harvested until the time it is consumed. As a major component of food systems, food waste is an unceasing resource-demanding commodity (Schneider, 2008), is connected with the environmental impact of its management and is linked with the social welfare of millions of individuals. Food and garden waste makeup 32% of the composition of waste produced in Europe (OECD, 1999; Smith, et al., 2001) and between 40 to 50% of the composition of waste in Latin America. This represents a considerable percentage of 'putrescible' matter discarded somehow, somewhere. Food waste handling not only has an impact on the environment but food waste itself has an important ethical dimension considering that population in many parts of the world face shortages of food, it is therefore for environmental, economic, social and moral reasons that special attention has been given to food waste in recent years.

At present (2012), the manufacture of vegetable and animal products for human consumption leads to a concentration of waste that is considered troublesome by those who centre their attention on the impact of food manufacture (Clover, 2008; FAO,1981; Stuart, 2009). The consequences of food waste itself when mixed with other discarded items, has shifted from being a distinctly ecological issue to a subject at the center of political and public attention. The amount of municipal solid waste to be collected, transported, separated and disposed of in many cities around the world is perceived as a serious challenge and represents one of the key items of sustainable development (Williams, 2005). The environmentally sound management of food waste requires therefore, looking at how discarded food items are managed in residential areas as they belong to the organic stream that make up a large component of what is disposed of in landfills.

Attempts to examine the relationship between the scale of food production and waste generation suggest different causes of unprofitable food items. Cultivation, transportation, product perishability and the market are referred to as some of the

main causal factors of food waste at a global level (FAO, 1989). It is estimated that nearly half of global food production is lost or wasted at some stage of the post-harvest system (Lundqvist, de Fraiture, & Molden, 2008). Such observations, raise the question of whether food waste minimization efforts are feasible in increasingly populated cities and whether these issues can be addressed effectively through government/municipal and private initiatives.

Any institutional effort to address sustainable food systems requires not only the examination of all aspects of the life cycle of food but also the establishment of certain criteria for diverting and reducing food waste at local levels. Figure 3-1 illustrates a food waste reduction framework adapted from the Food Waste Recovery Hierarchy introduced by the Environmental Protection Agency (USEPA, 2102a). This framework emphasizes tested mechanisms that help to divert food waste from landfills and that can be applied at local levels (i.e. in households and communities).

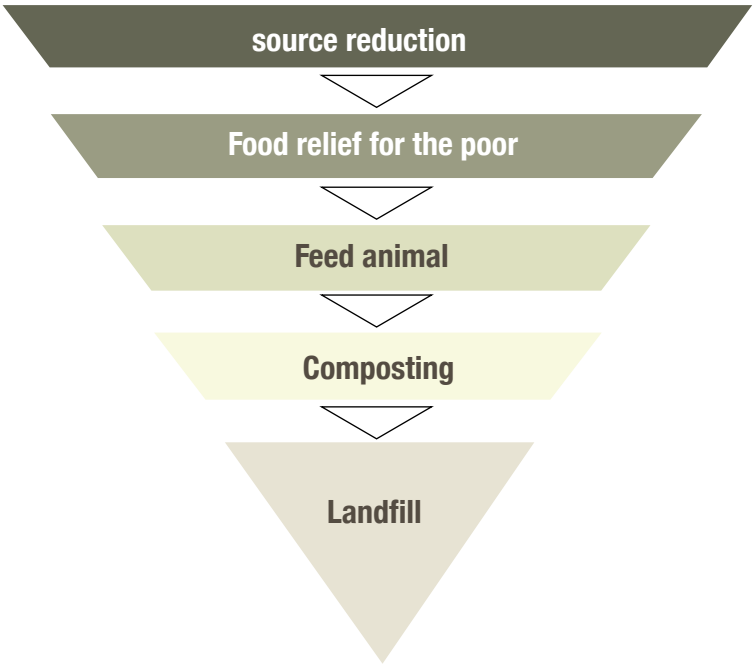

Figure 3-1 Criteria for diverting food waste at local levels

Source: Adapted from the EPA Food Waste Recovery Hierarchy (USEPA, 2012a)

The criteria proposed in Figure 3-1 suggests the need to deploy more effort towards understanding the causes for food waste at the source, recognizing the context in which it is produced, and identifying the appropriate avenues for recycling it. The framework includes reducing the amount of food being purchased, donating excess food, feeding animals, and treating food waste locally through composting before its final disposal.

In the literature, the difference made between 'food loss' and 'food waste' is in the stage in which the food product is diverted from the consumer. Food losses, also denoted as 'food spoilage' or 'post-harvest food loss' mostly appear in studies on food supply chains and other associated concepts such as food systems, food network and food system provisions (FAO, 1981; Morgan, 2009; Parfitt, Barthel, & Macnaughton, 2010). Food loss is frequently used by the Food Aid Organization (FAO) in the context of post-harvest food assessments and is defined as "a change in the availability, edibility, wholesomeness or quality of the food that prevents it from being consumed by people" (FAO, 1981: section 1.3). The idea that food losses represent commodities discarded in their whole state is also suggested by Fehr et al. who consider them as "entire food items that do not serve their purpose: they are thrown away without being considered for consumption, for whatever reasons there might be" (Fehr, Calçado, & Romão, 2002: 248). A clear example of this is contaminated horticultural crops that are lost before entering the food system market. These items perish due to a variety of causes ranging from inadequate harvesting to poor storage and/or preservation facilities. In short, food losses are related to the economy of food systems, which is not the focus of this research.

I recognize the complexity of food losses generated through harvesting, handling, storage, processing, marketing and final delivery to consumers. I also acknowledge the different overlapping factors in the food supply chain that may influence food wastage. However, the focus of this research is not on food losses. Rather, attention is placed on issues related to household food waste, which is a type of waste linked to individual waste habits. It represents what is discarded in kitchen bins after being purchased for consumption or the remains after food is consumed.

3.2 Household food waste

The food waste found in residential areas is regrouped under the classification of household waste. This classification incorporates, in addition to food items, other unwanted everyday household objects which are not considered in this research. The food waste generated from households is a biological substance with perishable proprieties. In contrast to other type of household waste, food waste is subject to decomposition that can occur at different stages depending on factors such as storage process, temperature, excess purchasing, shopping and cooking habits. In the European legislative context this type of waste is referred as putrescible waste or also as 'post-consumer food waste' (Parfitt et al., 2010).

The source of food waste production is an important consideration as it varies in composition and weight depending on its provenance. In residential areas, the amount of food waste is conditional to micro and macro socio/spatial determinants which differ from the refuse found in commercial establishments for instance. The waste generated from homes is diverse and remains speculative, that is why this research seeks to address the multiple determinants of food waste emerging from dwelling units. In developing cities, food waste make up to 50% of the waste composition of household waste. It is regrouped in the broader category of organic waste and remains poorly estimated partly due to the fact that an international standard method for conducting household food waste composition studies does not yet exist (Lebersorger & Schneider, 2011).

Household waste and municipal waste may often be considered as synonymous (Pongrácz, 2009). Indeed, municipal solid waste (MSW) is defined by the United Nations as "household waste and similar waste" (UNSD, 2009: 4). This includes bulky waste, which is voluminous unwanted items such as old furniture, found in

households; green waste such as garden waste (i.e. leaves, grass, tree branches); street sweeping products and market cleaning materials (UNSD, 2007). The definition of household waste retrieved from the European Topic Centre on Sustainable Consumption and Production (OECD/Eurostat Joint Questionnaire cited in EIONET, 2011) suggests that household waste may include waste from households as well as other types of waste with other provenance that are similar to waste from households. This is a vague and inclusive proposal which implies a connection between household waste and MSW. For clarification purposes, a schematic criteria are proposed in Figure 3-2. It considers municipal solid waste as a product that emerges from an urban setting and that encapsulates different types of waste generated in households, commerce and trade, small businesses, office buildings and institutions. MSW therefore includes household discarded items as well as other types of waste collected and managed at a municipal level.

Figure 3-2 Criteria for a food waste framework

The schematic criteria places the household as a 'focal denominator' for household waste (Pongrácz, 2002). This is a type of refuse that derives from domestic properties

which includes for the most part residences. It is clear that food waste is generated not only from households but also in restaurants, office buildings, hotels and other commercial premises that prepare food or where food is consumed. However in this study, household food waste is viewed as the waste produced mainly from households (i.e. housing units and similar). This situational distinction is stressed by scholars who consider food waste as the product of "food and drinks that are consumed within the home" (Parfitt et al., 2010: 3070), the notion is best applied to describe food items discarded at a later stage of the food system hierarchy and incorporates question of behaviors and attitudes (Parfitt et al., 2010: 3070). Or can be considered as the food that remains after the rest is eaten (Fehr, et al., 2002). These considerations include 'takeaway', 'homegrown' food and 'food retail' items consumed in homes; and exclude food consumed outside the home (i.e. in the workplace and /or in restaurants). There are commodities such as roots and tubers that are not fully edible. These remnants are also food waste, which implies that food waste cannot only be reduced to food scraps. Food wastage is also likely to occur during transportation, storage before its consumption in homes and often goes unnoticed. Commodities that turn into food waste are likely to be of a highly perishable nature which are inadequately handled. Indeed food waste can take many different forms. For the most part, it is considered as a food product discarded in its raw or cooked state and is an organic component of household waste embedded in the broader sphere of MSW.

Food waste legal framework and institutional effort

Food waste being part of the household waste mainstream does not have to date (2012) a legislation of its own. It is for the most part mentioned as an organic component of household waste different from garden waste. With regards to further classification of food waste, virtually every household waste composition study identified has established their own sub-category (Fehr, et al., 2002; Langley, et al., 2010; Lebersorger & Schneider, 2011; Morgan, 2009; Parfitt, et al., 2010; WRAP,

2008). Definitions and further groupings vary and are not all consistent one with another. Past studies have put forward food waste differentiations such 'truly edible' versus 'inedible parts of food products' (Morgan, 2009); 'avoidable' and 'unavoidable' (WRAP, 2009a, 2009b; Yiva Engqvist & North, 2011), and also considered food waste treatment appropriateness under labels such as 'recyclable food waste', 'suitable for compost' or 'suitable for biowaste collection' (Lebersorger & Salhofer, 2003). Other attempts to differentiate types of food waste are related to the life cycle stage of certain items mostly related to the pre-preparation stages i.e. (original food, preparation by-products, part consumed) and post-preparation (i.e. cooked food, leftovers, tinned) stages of meals, or common categories (i.e. vegetables, drinks, meat) (Lebersorger & Schneider, 2011).

Table 3-1 summarizes a selection of definitions drawn from different contexts. Common parameters are preparation and consumption of food.

Table 3-1 Selected food waste definitions

Definition of Food Waste	Context	Source
"Food waste is defined as including, but not restricted to, fruit and vegetable trimmings, outdated bakery goods and dough, dairy products, seafood (including shells), plate scraps (including meat) and leftover prepared foods, coffee grounds and filters, tea bags, floral waste, egg shells, slurry from pulpers, beverages and liquids such as vinegar. In addition, food waste might contain soiled napkins, tissues, compostable bags, plates, cups and packaging"	vector control	(Blackwell & Seamans, 2008)
Food scraps are "customary remains after consumption: the parts that are not eatable"	food waste recycling	(Fehr et al., 2002: 248)
food waste is an organic fertilizer able to increase microbiological population and enzyme activities and promoting nutrient in the soil .	composting and microbiological effect	(Lee et. al, 2004)
food and drinks that are consumed within the home	food system analysis	(Parfitt et al., 2010)
food substance raw or cooked which is discarded" or "all surplus food scraps	organic treatment policy	(Morgan, 2009; USEPA, 2012b; WRAP, 2008, 2009a, 2009b)

Attempts to signal food waste issues have been made through pilot projects and campaigns through several European initiatives in England, Finland and Austria. A prominent example is the "Love Food Hate Waste" campaign initiated in 2007 in Great Britain and was later adapted to the Australian context in 2010. The Australian campaign coordinated by the Department of Environment Climate Change and Water (DECCW) is predominantly a web-based initiative focusing on waste education, food conservation and food waste avoidance. It provides online information about the impact of food waste, appropriate food storage and smart food shopping. It also holds periodic food waste reduction workshops and establishes partnerships with food retailers, health organizations and local governments. In Australia, food waste constitutes 38% of generated waste in New South Wales (NSW), representing $2.5 billion Australian dollars per year according to a recent benchmark study undertaken on food waste behavior and attitudes (Office of Environment and Heritage, 2011). Australian households discard more than $5 billion dollars worth of food per annum (Baker, Fear, & Denniss, 2009). It appears that Australians consume less fruit and vegetables than they purchase. This "low consumption/high waste paradigm" stressed by Morgan represents a significant challenge in the continent (Morgan, 2009: 1). [1]

3.3 Food waste emission

The proportion of uneaten food discarded in residential dwellings contributes to financial and environmental liabilities and represents a waste of resources (Baker, Fear, & Denniss, 2009). Food waste mixed with other discarded items when collected, transported, sorted, transferred before it reaches its final disposal site may

[1] In 2010 there were several active regional programs aiming at improving the established food production model in New South Wales. In addition, different locally targeted food waste programs were launched. Predominantly they sought to stimulate discussions on food waste avoidance. For more information on institutional efforts addressing food waste in NSW, see Jean-Baptiste et al., 2010.

contribute to the contamination of the urban environment. These processes imply the combustion of fossil fuels through waste collection and transportation, the use of energy in transfer plants, as well as the release of several emissions in disposal sites at both global and local impact scales.[2] Figure 3-2 illustrates the global and local environmental impact of mixed household refuse including food waste.

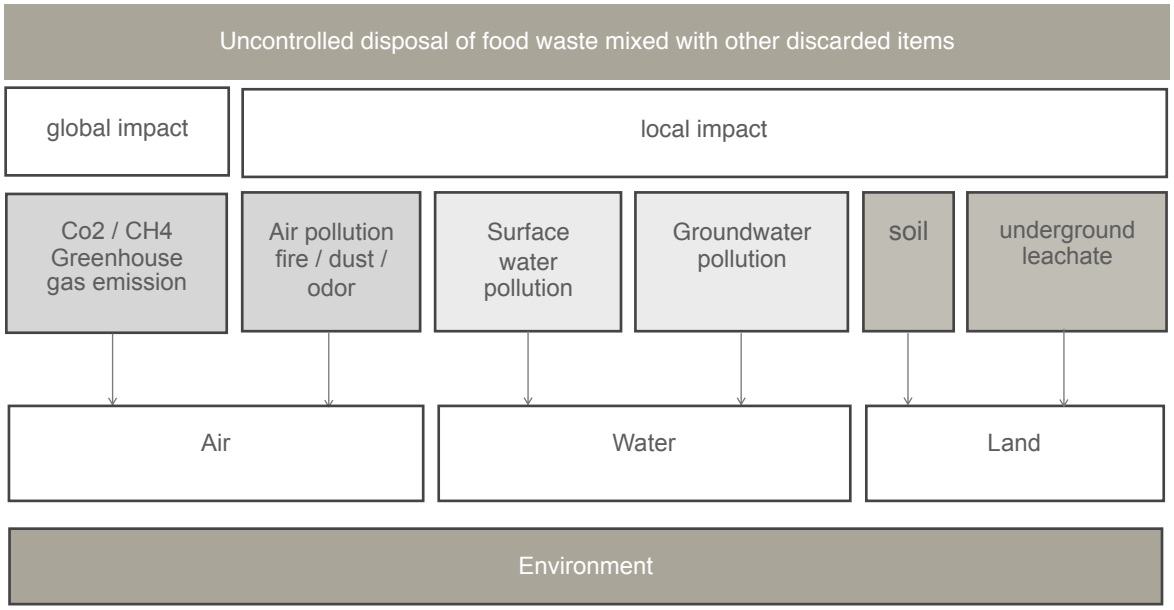

Figure 3-3 Global and local impact of household food waste in urban areas
Source: (Adapted from Jean-Baptiste, 2008; Meyer, et al., 2011)

Household food waste that fails to be processed based on environmentally-sound practices, poses a major problem to the natural urban environment when mixed with other items. For instance this type of waste has the potential to contaminate the natural environment (the air, both surface and ground water and the land), thus

[2] There are many forms of final disposal sites. The most common in developing and emergent countries is landfilling. Landfill are "the physical facilities used for the disposal of residual solid wastes in the surface of the earth" (Tchobanoglous, Theisen, & Vigil, 1993: 362). According to (Wheeler, 2004: 169-170), landfilling is the most used method in the American continent. It is also the oldest method of waste disposal worldwide and consists of burying waste in different layouts and forms by using the soil removed during the excavation as a cover layer

affecting human health and compromising ecological conditions (Bidlingmaier, 1990).

The global impact of food waste emission, is mostly referred to as the emission of Methane gas CH_4 in disposal sites as well as the emission of carbon dioxide CO_2 and Nitrous oxide N_2O. These gases rank high on the list of greenhouses gases. They are produced when organic waste - which incorporates a large quantity of food waste - is disposed of on the ground, in disposal sites and/or landfill in such a manner that bacterial decomposition is induced through anaerobic processes. Carbon dioxide described as "the most prevalent anthropogenic green house gas" is considered to have the highest concentration growth rate among all gasses emitted into the atmosphere (IPCC, 2011: 7). Methane gas is calculated as 21 times more effective at warming the atmosphere than carbon dioxide (Dow & Downing, 2006; Goudie & Cuff, 2002). The estimate rate of methane gas emission in landfill is about 70%, compared to carbone dioxide emissions, which are estimated to be 30% (Bilitewski, Härdtkem, & Marek, 1994).

While the global impact of organic waste is less noticeable in daily lives, the local impact of food waste emission is perceptible in several forms; in processes involving waste collection, transfer and disposal, food waste produces odor emission and attracts birds/rodents causing a number of nuisances. Organic waste mixed with other non-organic materials has the potential to contaminate land cover through leachate. More particularly, mixed waste accumulated in certain areas can damage the local vegetation due to the effects of chemicals on the soil and in the water. It also affects wildlife and food cycles and contributes to the breeding of bacteria and provides a favorable environment for vectors such as mosquitoes.

Table 3-2 provides further examples of the local impact observed during field trips to waste disposal facilities in Mexico, Australia and Germany between 2006 and 2010.

Facilities such as municipal composting plants, illegal waste dumps, disposal sites, separation plants, temporary recycling sites, incinerators, landfill, and anaerobic digestion plants were visited. A general observation is the variation of vulnerabilities to potential local impact and the measures taken to mitigate these risks. In some landfill sites it was observed that organic waste and all types of liquid waste were not accepted and standardized waste acceptance procedures were laid down so as to avoid risks and to minimize local impact. In the anaerobic digestion plant visited in Hamburg, it appears that priorities were given to reduce high operation costs by increasing efficiency through the choice of input material and pretreatment steps so as to allow a stable digestion performance, which primarily involves the removal of impurities and particle size reduction. In open air disposal sites where organic and non-organic materials were mixed, a string of problems made operations difficult in the field. The impacts mentioned in Table 3-2 below coincide to some extent to other statements from previous studies and the existing literature on solid waste management (Bidlingmaier, 1990; Bilitewski, Härdtkem, & Marek, 1994; Fehr et al., 2002; Tchobanoglous, Theisen, & Vigil, 1993; Lee et al., 2004; Blackwell & Seamans, 2008)

Table 3-2 Local impact of household waste containing mixed waste including food waste

Observations of local impact	Stage of the waste management process
Unsanitary conditions and occupational hazards leading to illness or sometimes death of the workforce in illegal waste dumps and disposal sites	waste collection and disposal
Transportation noise through heavy motor vehicles, traffic caused by waste collection activities and air pollution from waste vehicles	waste collection
Depending on the weather condition, the production of dust and the spread of particles are likely to occur during waste unloading activities.	waste transportation and separation
Technical problems during operations in composting treatment plants due to the nature of food waste (high level of moisture)	waste treatment
Food waste serving as attractants to birds and rodents in waste management facilities and causing concern to local neighbors	waste disposal
Food waste affecting the health of urban wildlife such as gull and birds	waste disposal

Observations of local impact	Stage of the waste management process
Odor emission of food waste caused by the concentration of decomposing organic matter	waste disposal
Disruption of the local ecosystem, (loss of vegetation) where large waste piles are concentrated	waste disposal
Local fire (air pollution) in poor managed disposal facilities	waste disposal

3.4 From a biological treatment view point

What does food waste means for composting? Studies on the properties of food waste suggest that several food waste items are rich in nitrogen, and when treated in a controlled manner, are in fact beneficial to land cover through the form of humus. It is therefore not uncommon to find food waste referred to as an organic fertilizer able to increase microbiological population and enzyme activities and promoting nutrients in the soil (Lee et. al., 2004; Pascual et al., 2008). Based on international standards most composting guides promote the use of food waste as a rich ingredient for urban soils. Composting is known to be essential in any sustainable municipal solid waste management program, as it diverts a large portion of organic waste from dump sites and landfill and contributes to the stability of soils and enhances agriculture and green activities. It is a natural process which when undertaken under favorable environmental conditions transforms food waste and garden waste into a substance that can improve the soil and promote plant health. The end product is a biologically stable, humid substance that makes adequate soil amendments.

There is much written on the science and technology of composting.[3] While some books focus on the chemistry and micro-biology fundamentals of composting others

[3] See: *Composting and Recycling Municipal Solid Waste* by Luis F. Diaz (1993), *The Science of Composting* by M. de Bertoldi (1996), *The Science of Composting* by Epstein (1997), *Compost Science and Technology* by Luis F. Diaz, M. De Bertoldi, and Werner Bidlingmaier (2007).

address the technical aspects of large scale composting activities. Regardless of the different techniques (e.g. windrow aerated methods, static piles, in-vessel composting), scale (backyard composting, bin composting, tumbler composting), or rate (i.e. slow or fast composting), the composting process follows for the most part three main principles.

The initial phase takes place through the functioning of microorganisms during the degradation process. Under natural conditions earthworms and soil insects do most of the initial breaking down of the food into smaller particles. In this phase, compost practitioners often accelerate the process by shredding particles into smaller portions.

The following active phase occurs when the temperature rises through microorganisms that activate with temperature above 55°C. As the temperature in the compost pile increases, hygienic processes occur and thermophiles react killing pathogens and weed seeds. In this phase, temperature can rise up to 65-70°C, the input of oxygen is crucial in order to aerate the piles and to provide the necessary oxygen for the microorganisms to work in optimum conditions.

The final curing phase initiates when the oxygen flow and temperature of the piles are reduced. During this phase, organic materials continue to decompose. The duration of the curing phase is proportional to the type of compost obtained and the final appropriate use. The end product is often differentiated into a finished or a mature compost. A finished compost might be suitable for landfill application but not appropriate for garden plants. A mature compost is defined by the degree of humidification and stabilization of the material.

The quality of compost depends on the quality of the input material. In some countries, the combination of food waste suitable for compost, garden waste, animal manure and other biosolids produces a variety of market-orientated products with different chemical and physical characteristics. In recent years, the composting industry has grown increasingly entrepreneurial and private sector driven, shifting

therefore from one once dominated by public sector operation and contributing to a green economy. In its simplest form, large or small efforts at composting of food waste should consider the following sustainability factors:

- **The decomposition process must be controlled in a facility/contained area**
- **To manufacture compost of good quality, organic material suitable for compost must be obtained**
- **Appropriate market or use for the end product needs to be identified**

Benefits of compost

The uses and benefits of compost have been stressed in different studies (Niemeyer & Sanders, 1999; Shiralipour, McConnell, & Smith, 1992). In urban areas good quality compost can be used as soil amendment or mulch in urban agriculture and in commercial greenhouses and farms. Compost is known to be used by local municipalities to protect the soil of green areas, parks, and on the side of roads. Compost can also be utilized where there are erosion problems and also as a low cost cover material in landfill. Table 3-3 summarizes the environmental and economic benefits of composting organic waste in urban areas. These considerations apply mostly for developing and emergent economies where compost activities can play a more dominant role in treating household organic waste produced in growing cities.

Table 3-3 Environmental and economic benefits of composting food waste

Environmental benefits	Economic benefits
Improve the soil structure and aeration in areas where the soil consists of sand and clay	Composting is a low cost technology; it reduces costs of solid waste final disposal
Improve the water holding capacity in sandy areas and prevent erosion	Compost reduces the amount of waste in landfills therefore increases the life span of disposal sites

Environmental benefits	Economic benefits
Compost can be used as fertilizer providing nutrients to the soil and promoting plants health and improving the fertility of the land	Compost is a low cost alternative covering material for disposal sites
Help improve the urban ecosystem through gardening, botanical / urban agriculture activities to sustain parks and open green areas.	Composting can be used as a trigger to promote more city greening activities, especially through botanical and landscaping activities, which may lead to a potential compost market

3.5 Food waste category

The literature on the categorization of food waste commonly includes fruits and vegetable peelings, dairy products, meat scraps as well as breads and other items. However, discarded beverages such as spoiled milk or other by-products such as coffee grounds, tea bags or tea leaves do not always appear as food waste. For that reason, this research embraces a broader sense of food waste. This is central to accurately assess its composition through the instruments designed to collect data at the household level. Such definition takes into account the food waste found in homes and recognizes that it may on occasions incorporate soiled napkins, tissues and papers bags as well as slurry food mixture and beverages.

In this dissertation, any organic by-product that emerges from the preparation and consumption of food has the potential of being converted into food waste. This consists of all edible items found in the household with the purpose of being consumed. Food waste incorporates entire food items discarded prior to consumption, food scraps, uneaten leftovers, fruits and vegetable and peelings, excess cooked food, outdated bakery goods, and spoiled dairy products. In the context of the study, food waste includes, but is not restricted to "comfort food" such as chocolate bars, candy, ice cream and desserts consumed in most households.

Table 3-4 illustrates the classification proposed and that later served as the main criteria for identifying the type of waste produced in the pilot studies and fieldworks cases investigated between 2008 and 2010.

Table 3-4 Proposed classification of food waste for data collection

Description	Example
	Spoiled cooked food/excess cooked food
Processed food that has become unfit for consumption due to microbial or environmental contamination. Or simply excess cooked unconsumed food. Examples: •excess cooked rice •spoiled leftovers •uneaten cheese sandwich •slice of bread •leftover cake	
	Fruit/vegetable peelings
Strips of outer skin of any fruits and vegetables discarded prior or during meal consumption. Examples: •potato peelings •apple skins •carrots trimmings •avocado seed	
	Beverage
Any liquid refreshments or others(without package/container) Examples: •excess milk •leftover coffee •unfinished tea	
	Raw food/ meat scraps
Uncooked animal source products such as raw meat scraps and similar, as well as non-edible meat remnants. Examples: •skin flesh from any food not yet processed •meat joint in its natural state •seafood waste including shells •bones and/or chicken leg •unfinished sausage	

Spoiled Cooked Food and/or Excess Cooked Food

This category regroups processed food that has become unfit for consumption due to microbial or environmental contamination. This classification intends to signal that the amount of food not being consumed although processed for the purpose, also may provide more insight on household consumption opportunities and current trends. Some commonly spoiled food items are: old leftovers, moldy dairy products, stale slices of bread and decomposed sauces, excess cooked rice, uneaten sandwiches. This category is particularly associated with income, modern consumption trends, eating habits and culture.

Fruit and/or Vegetable Peelings

Fruit and/or vegetable peelings are the strips of outer skin of any vegetables and fruits discarded in the household and also unconsumed fruits and vegetables items. These are plant-based products promoted not only in nutrition discourses as healthy dietary elements for humans and animals, but also considered as source of protein for the soil. Fruit and vegetable peelings are high in moisture and nitrogen and can under optimum conditions contribute to improving soil regeneration and to plant health. When one speaks of organic waste for compost, it is actually this type of waste that is targeted as it is able to produce a rich end product able to protect and restore the top layer (soil) of the land's surface. This category is also tied to income, consumption trends, eating habits and culture.

Beverages

Beverages are understood as liquid refreshments that are incorporated as a separate entity in the systematization of food waste produced in households. Drinks are an important item of human consumption and make up for a substantial amount of comestible items purchased by an average family. Beverages as well as food are commodities that are symbolic to daily practices serving as "signifiers of group culture and identity (Wilson, 2006: 12). Thus it is useful to examine the extent of

beverage losses in the household. The drinks include the following subcategories: fruit juices (e.g. left over or spoiled of apple juice), soft drinks (e.g. unfinished carbonated drinks), hot beverages (e.g. leftover tea or coffee) and alcohol beverages.

Raw Food and /or Meat Scraps

This category regroups uncooked food losses relative to animal source products such as raw meat scraps and similar, seafood waste including shells, as well as non inedible meat remnants such as bones. The emphasis given to this type of food residual echoes the diversity of opinions regarding proper biological treatment and management of animal-based food residues. The treatment of food waste including meat fractions suggest issues related to vector control, underlying the need to minimize waste material that may serve as an attractor to birds and mammals. Whether or not this food category is suitable for compost, the concern in this research is to examine to what extent raw food and meat scraps make up for the composition of the waste bins in the households investigated. Do they base their diet on processed goods and services versus home-produced goods from raw materials? This category provides some elements of reflection concerning the dominant consumption style of the household. It includes excess skin/flesh from chicken/beef, meat, bones from fish, shrimp shells, chicken legs, pork bones, left over sausages and similar. As is it the case in the categories above, this classification has a strong connection with eating habits, income and culture, for instance in some locations, this category may also includes animal skin and fat, gristle, connective and nerve tissues, blood and blood vessels.

The discussion of environmental problems connected with household waste has been mainly concerned with the volume of waste due to the many implications of the final disposal of household waste in landfill. Other problems connected with specific determinants and components of waste are given less priority. This thesis suggests that both external and internal determinants and waste composition in each household influence the volume of waste to be

managed. The categorization above helps identify the types of food waste output in the fieldwork cases investigated in the research.

Food waste management starts as a private act and then turns into a public act. Producing, storing, sorting, collecting, transporting and burying food waste interconnect with numerous institutional, political and environmental aspects of the urban life. The following chapter explores the culture of food waste management in Mexico and highlights some spatial considerations that makes its Central Region uniquely challenging. The next chapter takes into account different interpretations relative to current institutional structures and spatial settings. It draws not only from specific literature related to Mexico's current waste legislation, programs and governmental reports, but also from conversations with practitioners and reflections made through exchanges with different actors on some of the challenges that Mexico City and its surrounding faces.

4. Food Waste Management in the Mexico City Metropolitan Area

Chapter 4 presents the context of Mexico City in which waste management unfolds, it first summarizes the national state of waste management and highlights critical issues regarding the growth of the population in urban areas and the multiple difficulties local authorities face with waste collection, transport, and final disposal. The chapter signals the expansion of the Mexican capital and how its growth play a role in infrastructure and service procurement. It centers its attention on the Mexico City Metropolitan Area (MCMA) and its transport and housing challenges. It finally focuses on the Federal District and the different actors that interact in current food waste management practices.

4.1 The national context in which waste management unfolds

Some of the most critical issues regarding waste management in Mexico are the growth of the population in urban areas, the physical expansion of urban territories and the challenges faced by local authorities and practitioners with regard to environmentally-sound waste collection, transportation and final disposal. Urban development is one of the most central causes of land use change in the Mexican territory and urban expansion will continue although at an inferior rate to the one predicted at the end of the 1990s. Mexico has an annual population growth rate of 1.8% and hosts a population of 112.34 million inhabitants of which 77.8% is urban. (For these and more statistics about Mexico, see: López-Acevedo, 2007; UNSD, 2010; Weiss & Rosenblatt, 2010; World Bank, 2002, 2011a, 2012).The country covers 1,964,375 km^2 with a density of 57 hab./km^2 and the median age of 26 years (Censo de Población y Vivienda, 2010 in INEGI, 2010c). Security has been considered a national priority due to growing urban violence in recent years and economic growth is expected to stay at 3.3% in 2012 partly due to external demands for manufactured goods such as machinery, crude oil, meats, dairies, fruits and vegetables (World bank, 2011).[1]

The central region of Mexico which comprises 6 distinctive federal entities (Federal District, State of Mexico, Morelos, Hidalgo, Puebla, Querétaro and Tlaxcala) is an important economical and political hub generating about 41% of the nation's gross domestic product. The economic policy agenda revolves around this particular region, which is confronted with in-land migration and strong pressure for the relocation of economic activities in other parts of the country.

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[1] In recent years, there has been considerable research on the evolution of Mexico's economic growth (Chiquiar, 2005; Crandall, 2005; Sanchez-Reaza, and Rodriguez-Pose, 2002). There is also a vast literature on institutional and social determinants of economic growth, dealing with key items such as government transparency, security and free trade. A comprehensive discussion on Mexico's economic and political perspective is considered out of the scope of this research, for more information see the World Bank's Mexico country brief database which includes a number of recent papers available online at the following URL: http://www.worldbank.org/en/country/mexico/research (World Bank, 2012)

Figure 4-1 Map of Mexico and central region

Source: Aguayo Quezada, 2008; INEGI, 2010

Figure 4-1 shows a map of Mexico and highlights the Federal District, the State of Mexico and the state of Morelos. The empirical research discussed in the next chapters was conducted within these three distinct jurisdictions. A socio-demographic and economic overview with the most recent statistical data on the age composition, housing situation, birth and mortality rate, education, marriage, ownership rate and spoken languages is annexed for each jurisdiction in Appendix A-2.1, A-2.2, A-2.3.

Mexican practices of waste management can be traced back to pre-columbine times. Ancient documents describe frequent cleaning events from *Mexicas* who ruled over the Aztec empire on *Tenochtitlán*. *Tlazoltótl* was their 'God of Waste' particularly celebrated during *Ochpaniztli* festivities when communal cleaning activities occurred. It was said that *Mexicas* cleaned thoroughly their houses, streets, temples, gardens and markets based on the idea that the community and neighboring surroundings were an extension of themselves. In these times, domestic waste was buried in each household, organic waste served as animal feed or was mixed with green foliage as a form of compost (Lameiras & Pereyra, 1974).

Efforts towards implementing municipal collection systems were reported at the end of the 18th century. Operations that were more systematic as well as data collection were reported a century later. The first sanitary code dates from 1891 and was established by the Health Council. Subsequent endeavors to control municipal solid waste in Mexico were conducted more systematically from 1960 onwards, when the first landfill was designed and operated north west of Mexico City in Aguascalientes. This marked the beginning of a series of efforts to integrate practices of waste collection and sanitary landfill in the most important metropolitan area of the country (Armijo de Vega, 2006; INE, 2007).

More particularly, with regard to organic waste treatment, three pioneer municipal composting plants were established between the end of the 1960s and beginning of the 1970s. The plants were given the name of the city which hosts them: the Toluca composting plant was established in 1969, followed by the Guadalajara plant in

1972, and the Monterrey composting plant was established in 1973. The purposes of these plants were firstly to improve recycling by separating the organic fraction in the municipal waste stream, secondly to prolong the operating life of active landfills, and lastly to improve the life of human scavengers. All three plants were proven to be economically unsustainable for the municipality that operated them and they suspended their operations a few years later.

The composting culture in Mexico's central region is restricted by the lack of continuity of municipal programs, lack of comprehensive planning before carrying out compost activities, legal limitations to market compost derived products and the introduction of technologies that are often incompatible with local waste budgets and existing infrastructure. During a pilot study commissioned by the Mexican Institute of Ecology in 2005, 61 establishments were identified, many of which were inactive or operating sporadically. The organic waste treated was mostly garden, food and animal refuse. Most plants combined two or three different types of waste in their piles due to the primary materials, to which they have access. The nature of the end product is therefore conditioned to the type of waste they received. The composting facilities identified in the Mexican Central Region are operated and administered mostly by public entities and educational centers, however some smaller scale plants are promoted by environmental institutes, universities and private entrepreneurs. Mexico City's local authorities operate the largest composting facility in the republic, located south west of the capital. The plant is known as *Planta de composta de Bordo Poniente* and receives approximately 100 Mg. per month. Plants such as this one run by municipalities tend to use garden waste from public green areas most frequently. This type of waste is combined with refuse from large organic waste producers such as local markets, restaurants, hotels, food industries and farmlands. Source-separated household waste is scarcely utilized. Private promoters mostly process waste generated on their own properties. Lastly, compost plants managed by educational centers work in cooperation with schools and use their own organic waste.

The compost produced is mostly utilized as a fertilizer for garden areas and public green spaces within the localities. Only a small fraction is used in agricultural fields. Legal impediments and inconsistent quality control make compost commercialization difficult in Mexico. The end product from universities and other teaching establishments is used to improve the soil within their facilities, as well as for educational purposes and research. The product is rarely commercialized. Private promoters trade their compost to farmers and green garden owners.

Passive composting piles were most commonly identified, with a relatively small number of facilities combining worm composting techniques as well. Accidental anaerobic processes occur at many plants due to a lack of training and insufficient equipment to ensure proper aeration. It takes 3 to 6 months to produce compost at most large scale composting facilities in Mexico. The information on the volume of end product is inconsistent at most facilities reviewed. The larger locations produce between 25 to 100 Mg. per month. Smaller centers produce 1.5 to 9 Mg. monthly.

In 1976, more attention was given to solid waste management in urban areas and in particular to solid waste disposal challenges. In fact, during the 1970s and 1980s key waste management programs were pursued nationwide. Pilot projects, training programs as well as environmental institutions emerged; they aimed at identifying and systematizing solid waste including industrial waste in large cities. The Sub-ministry for Environmental Improvement (*Subsecretaría de Mejoramiento del Ambiente, SMA*) was among the first federal organizations which worked towards standardizing the control of municipal solid waste. The RS100 program which was initiated in 1983 prompted sanitary landfill projects for cities above 10,000 inhabitants and the elaboration of waste collection routes (INE, 2007; SEMARNAT, 2012).

The beginning of the 1990s marked the creation of two federal institutions, the Ministry of Social Development in 1992 (*Secretaría de Desarollo Social, SEDESOL*) and the Ministry of Environment and Natural Resources and Fishing in 1994 (*Secretaría de Medio Ambiente, Recursos Naturales y Pesca SEMARNAP*) which together

formed the National Institute of Ecology created in 1992 (*Instituto Nacional de Ecología*). While SEDESOL provided structural financial support with regard to the construction of the infrastructure to control municipal solid waste and operate landfills, SEMARNAP focused rather on the regulatory frameworks of solid waste management and fostered the establishment of norms and control mechanisms such as the Normas Oficiales Mexicanas (NOM) which institutionalized the selection of sites for landfills in the country (INEGI, 2010c). At the beginning of the 21st century, SEMARNAT was superceded by SEMARNAP, Secretaria de Medio Ambiente, Recursos Naturales focusing its attention on natural resource protection and strengthening the environmental protection aspect of the current Mexican waste management regulatory framework.

The central region of Mexico is not without regulatory frameworks as well as programs designed to implement enacted solid waste management laws(SEMARNAT, 2009). The Federal Law for the prevention and management of solid waste was enacted in 2003 and is locally known as '*Ley general para la prevención y gestión integral de los residuos*'. Progressively several other state mandates and state laws have followed focusing on compelling waste separation at the source and integrated waste management strategies. For instance, the Waste Law of the State of Morelos of 2007 stipulates that household solid waste should be separated into organic and non organic streams and waste separation is mandatory in all households in Morelos (Gobierno del Estado de Morelos, 2007). While there appears to be a clear policy and regulatory distinction between organic and non organic waste adopted across the nation, it has not been entirely implemented in Mexican cities. A large portion of the waste collected is mixed and separation at the adoption of source remains a slow process.

Several institutional entities as well as operational/technical agencies and practitioners interact within Mexico's larger environmental policy agenda. Experts indicate however that a well-defined command structure with clear roles and responsibilities is yet to be established. This results in duplication of institutional efforts and overlapping roles that ultimately foster gaps and differences between

official government data (Buenrostro & Bocco, 2003; Gutiérrez Avedoy, 2006). Table 4-1 summarizes the main federal and regional bodies concerned with waste management in Mexico.

Table 4-1 Institutions concerned with waste management in Mexico

Name	Function
SEMARNAT	The Ministry of Environment and Natural Resources is a federal government agency which is responsible for promoting the protection and conservation of ecosystems and natural resources, as well as providing environmental goods and services (SEMARNAT, 2012, www.semarnat.gob.mx).
SS *Secretaría de Salud*	The Ministry of Health determines sanitary control and is responsible for regulations and levies regarding health related matters. It also elaborates the parameters for the protection of public health regarding solid waste (Secretaría de Salud, 2012, www.portal.salud.gob.mx)
SEDESOL	The Ministry of Social Development promotes and creates infrastructure for urban development and is responsible for developing resources such as waste related studies and projects (SEDESOL, 2012, www.sedesol.gob.mx)
Satellite governmental agencies	They support and follow the Federal government's waste management regulatory framework federal regulate solid waste management issues in their respective entities (tourism, industry, energy, transport and habitat among others)
State governments	Support and regulate solid waste management in their respective state jurisdiction and create state infrastructure for the final disposal of solid waste
Municipal governments	Responsible the waste collection, transfer and final disposal as well as street cleaning. They also formulate local regulatory frameworks and enforce waste management law
NGOs, CBOs, international development agencies	Make available, coordinate and manage funds for waste management projects; offer technical assistance and capacity building. They also develop programs for reuse and recycling, promote waste education on environmental awareness, and execute projects at community level (GIZ, GIRESOL, JICA among others)

Source: (Adapted from FAO, 2011; Gutiérrez Avedoy, 2006; INE, 2007; SEMARNAT, 2009)

According to Gutiérrez Avedoy (2006), the first trustworthy estimations with regard to urban solid waste were generated in the 1980s by several federal government agencies and appear in the Mexican literature as Solid Urban Waste RSU *residuo sólido urbano*. In the 1990s more data was generated by institutions such as the Ministry of Social Development SEDESOL and the Government of the Federal District, which are paradoxically widely referenced and contested in the local literature. Other national and international institutions such as INE, GIZ, JICA and BANOBRAS have also generated their waste data (2006).

According to the Ministry of Social Development SEDESOL, the total of urban solid waste generated in Mexico in 2004 is 94,800 Mg./da daily which represents 34.6 million Mg. per annum. 87% thereof is collected.[2] With 70% of the Mexican population living in ten cities, those hosting more than 5 million inhabitants face some difficulties in waste collection and final disposal. Statistical literature indicates however that the larger the metropolitan area, the higher is the coverage of waste collection. The coverage of waste collection may vary from 95% in large urban centers, to 75-85% in medium size cities, to 60%-80% in small urban areas. These estimations are contested by those suggesting that Mexican cities collect less than 75% of the waste generated that constitutes a source of pollution (Medina, 2005). The coverage of municipal solid waste management is inferior to other services such as energy and water supply. With a municipal budget varying from 20-40%, local authorities are faced with several obstacles to effectively manage the cost and operation of solid waste management. Areas not covered by municipal waste collectors are then serviced by the informal sector which is considered an important urban labor force particularly in low-income settlements (Medina, 2005).

[2] Confusion of terminology in the Mexican legislation has been signaled by several local experts. Buenrostro and Bocco (2003) for instance suggest that uncertainties in official terminologies have technical, planning and regulatory consequences and influence inconsistencies in the generation as well as in the interpretation of data . In this thesis, the data on waste generation emerged from primary sources mainly from government reports which when possible were triangulated with other secondary sources such as technical papers in scientific journals and/or reports produced by development agencies.

In large urban areas, the most common waste collection vehicles are rear loaders with a capacity of $10m^3$-$15m^3$ which collect between four to eight Mg. per trip. It is estimated that 53% of the total waste generated is organic and 28% has the potential to be recycled (SEDESOl, 2005). Table 4-2 illustrates the volume of urban solid waste generated from 1995 until 2010 in the Mexican republic.

Table 4-2 Volume of municipal solid waste generated in urban areas in Mexico

	waste generation		final disposal			
	organic waste	other a)	sanitary landfill b)	controlled landfill c)	waste dump	recycling d)
1995	15 987.0	5 754.1	5 952.0	2 555.0	21 283.6	719.0
1996	16 746.7	6 027.5	8 573.0	2 606.0	20 027.0	753.2
1997	15 338.8	5 520.8	10 270.0	1 657.5	16 655.1	689.8
1998	16 008.5	5 761.8	15 877.1	1 007.5	12 945.9	720.0
1999	16 218.8	5 837.5	16 428.7	507.5	13 286.4	729.4
2000	16 104.1	5 796.2	14 490.5	2 421.8	13 096.5	724.3
2001	16 500.0	5 938.7	15 252.7	3 351.9	12 141.9	742.1
2002	16 859.0	6 067.9	15 579.9	3 630.9	12 182.4	780.5
2003	16 592.8	5 704.3	17 431.0	3 709.3	10 954.8	820.5
2004	17 440.0	5 996.1	18 586.3	3 718.7	11 402.0	895.0
2005	17 968.0	6 022.0	18 832.4	4 078.6	11 344.0	1 150.0
2006	18 335.0	6 022.0	19 772.1	3,763.5	11 423.4	1 176.0
2007	18 576.0	6 385.7	20 846.6	3 844.9	10 971.3	1 202.2
2008	19 707.3	4 552.8	21 822.6	3 545.6	10 880.0	1 346.8
2009	20 090.0	4 641.2	22 444.6	3 554.0	10 953.4	1 373.0

a) includes construction waste and others materials such as rubber and discarded diapers

b) sites which comply partially with environmental and sanitary requirements pre-determined in disposal sites

c) sites with minimum conditions for waste compaction and daily coverage without infrastructure to comply with environmental and sanitary requirements for landfills

d) material retrieved from disposal sites does not include prior recycled items from separation sites and others sources.

Source: Adapted from INEGI, *Anuario Estadístico de los Estados Unidos Mexicanos*, 2010a

4.2 The culture of food waste management in the Mexico City Metropolitan Area: from context to practice

As mentioned above, the majority of the fieldwork cases investigated in this research study are embedded in the Mexico City Metropolitan Area (MCMA) known as *Area Metropolitana de la Ciudad de México*. Mexico City's expansion has been well documented. Since the 1970s, studies focusing on the development of the urban environment in Mexico and Latin America include topics such as: MCMA's spatial transformation and social segregation (Aguilar, Ward, & Smith, 2003; Pérez Campuzano & Santos Cerquera, 2010; Rubalcava & Schteingart, 1985, 2000; Schteingart & Salazar, 2005), the effect of globalization and regional development on peri-urban areas (Aguilar, et al., 2003), the expansion and pressure on urban services in MCMA (Gwilliam, Kojima, & Johnson, 2004; Medina, 2005; Tortajada, 2006)) as well as urban settlements, land use and typology and their environmental consequences (Bocco, 2009). These socio-economic based studies identified a link between global processes and regional structure and how they shape local processes both spatially and socially. They also cover a wide spectrum of the transformation of urban spaces in Mexico. This thesis focuses less on economical development and the causes of transformation of MCMA and offers a general view on how waste management unfolds in such expanded area and highlights urban service challenges that hamper environmentally sound practices.

4.2.1. Regional boundaries and urban expansion in MCMA

The concern for examining the transformation in MCMA resides in the fact that there are ever more indistinct boundaries between the core and the periphery. This was confirmed while conducting fieldwork activities. The urban context of food waste management in Mexico City extends beyond the core city limit and the development of new 'poly-centric' urban arrangements play a role in the external determinants affecting food waste management. Indeed, many social and economic activities and overall dynamics of Mexico City's metropolitan development take place

beyond the Federal District, in its extended settlements on the periphery, which are not necessarily considered in the formulation of integral environmental and development metropolitan planning.

The first systematic attempts to define Mexico's metropolitan areas were conducted in the 1970s when 12 metropolitan areas - including Mexico City - hosting more than 100,000 inhabitants were studied. In 1990 Mexico City's inner area and extended settlements were officially introduced as *Zona Metropolitana de la Ciudad de México*, comprising all 16 boroughs *delegaciones* in the Federal District as well as 38 municipalities *municipios* of the neighboring State of Mexico (Jordan, Rehner, & Samaniego, 2009). The latter comprises a total of 125 municipalities and extends over 22,357 km^2 (INEGI, 2010b) with a population of 14,638,436 million inhabitants estimated in 2008 (Aguayo Quezada, 2008). In 2005 new boundaries were established to form what is known today as *Zona Metropolitana del Valle de México (ZMVM)* which is the largest urban agglomeration in the country comprising three different federal entities (*Hidalgo, Districto Federal, and the State of Mexico*) with a total of 76 municipalities (CONAPO, SEDESOL, INEGI, 2007).[3]

MCMA is embedded in ZMVM and its footprint continues to develop progressively. This wider urban context includes an important industrial and commercial concentration as well as a conglomeration of boroughs and municipalities that share a number of different natural resources and urban public services. Figure 4-2 illustrates the urban footprint of MCMA. The Federal District hosts approximately 8,851,080 inhabitants which represents 7.9% of Mexico's total population and covering 1,486 square kilometers (INEGI, 2010c). The area concentrates not only close to 18% of the Mexican population but also generates a third of Mexico's gross

[3] In this thesis, there is a distinction made between *Zona Metropolitana del valle de México (ZMVM)* and Mexico City Metropolitan Area (MCMA). The limits of ZMVM are based on jurisdictional criteria which incorporates entire boroughs and municipalities. The criteria for MCMA's delimitation however takes into account the physical continuity of the urban footprint which is less distinct and may include parts of territorial units (CONAPO, SEDESOL, & INEGI, 2007).

domestic product in less than 0.3% of the nation's surface (World Bank, 2011b). The city area is located at approximately 2, 240 meters above sea level in a natural closed basin surrounded by mountains (INEGI, 2010c). The series of mountains located on the southwest side of the capital reach altitudes of up to 3,900 meters and constitute a natural barrier that prevents the flow of dominant winds from the northeast, thus trapping polluted air within the valley particularly at periods of thermal inversion.[4]

MCMA comprises distinct entities with geopolitical and administrative units which are governed by different political leaders with different economic and environmental agendas. A sum of 42% of the metropolitan population lives in the Federal District, where the density level (although decreasing) remains among one of the highest in the Latin American region with 5,920.5 hab/km^2 (World Bank, 2011b). The region has featured a continuous physical and demographic growth since the 1930s and substantial growth in the second half of the 20th century. It is an area at risk of seismic activity and is also vulnerable to flooding.[5] It extends through numerous urban sectors, stretching from the State of Mexico in the north, through the Federal District and into the State of Morelos in the south. Although the pace of growth is irregular in different areas, it did not reach the alarming rate predicted in the 1990s (Aguilar, et al., 2003; Rowland & Gordon, 1996). MCMA features a continuous urbanized development described as 'leapfrog expansion' characterized by limited urban spatial planning (World Bank, 2011a, 2011b).

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[4] The term thermal inversion describes warmer air trapping cooler ground air beneath it. In Mexico City the warm air settles over a layer of cooler air causing and preventing pollutants from rising and scattering into the atmosphere.

[5] The 1985 earthquake as well as other events such as flooding have pushed dwellers to settle in less vulnerable sectors outside the oldest quarter of the capital. The Historic Center of the Federal District is particularly known for its fragile soil. The area was drained in the 1600s and 1700s and built on the clay bottom of the old lake *Texcoco*. The cathedral, which weights over 160,000 Mg., stands on 22,500 wood pilings and has been supported by scaffolding and tension cables for over 15 years to prevent a potential collapse. These natural threats have to some extent contributed to in-land migration outside the Federal District.

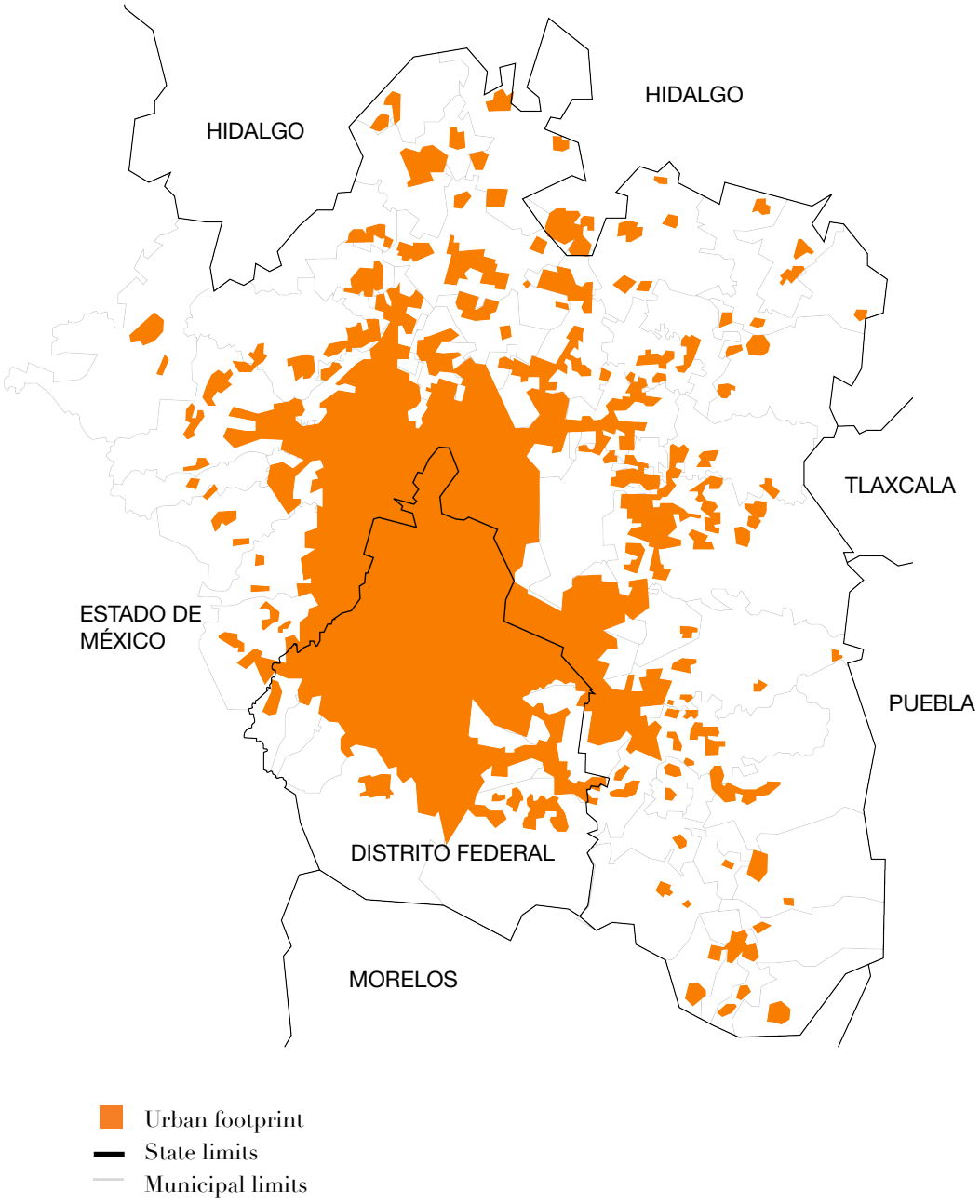

Figure 4-2 Map of Mexico City Metropolitan area - MCMA

It is important to mention that there is some disparity between the rates of growth in different zones of MCMA. On the one hand the Federal District shows a growth rate of 0.2% from 2000-2005 but on the other hand the State of Mexico featured a growth rate of 1.2% in the same period. These numbers suggest different population growth especially in the peripheral areas. Such growth continues to exercise pressure on the

natural environment and generates both human and ecosystem interactions proper to MCMA.

With regard to MCMA's institutional organization, most scholars are anchored in the view that it remains a divided mega city both spatially and politically (Aguilar, et al., 2003; Jordan, et al., 2009). The area comprises several autonomous jurisdictions with local governments (boroughs and municipalities) with limited administrative power, financial resources and coordination between them. All these units are embedded in a larger political realm ruled simultaneously by leading opposition political parties. The Federal District's major authority is the head of Government *Jefe de Gobierno*, previously lead by Marcelo Ebrard is currently (2013) Miguel Ángel Mancera who is a member of the *Partido de la Revolución Democratica* PRD and has similar authority as any Mexican State Governor. The State of Mexico, comprising a large portion of the Mexican primary sector, is currently (2013) ruled by Eruviel Ávila Villegas, a member of the *Partido Revolucionario Institucional* PRI. Mexico City is also the siege of the Federal Government lead by Enrique Peña Nieto currently President of the United Mexican States *Presidente de los Estados Unidos Mexicanos* and who is affiliated with the *Partido Revolucionario Institucional* PRI. This challenging political scenery influences the way in which decisions are made to shape and restructure Mexico City and has been widely debated since the beginning of 2000. MCMA is indeed known for its 'fractured government'. Common criticisms are the lack of effort to coordinate urban and environmental programs, the lack of centralized resolutions and the existing institutional gap between the Federal District and the State of Mexico. In addition, the country's deep-rooted centralist character is being challenged by competitive smaller jurisdictional administrative entities manifested through a cluster of political forces governing from the wider ZMVM region. Important local and national political, economical and social decisions as well as environmental milestones occur in MCMA. Key decision makers operate within a complex web of authority structures which are summarized in Table 4-3.

Table 4-3 Mexico City's power structure and political constellation

level/ scale / city limits	Estimated population	Authorities
Mexico City Metropolitan Area MCMA	20,000,000	No metropolitan authorities
Mexico Federal District	8 851 080	Head/ Chief of government *Jefe de Gobierno*
Federal District boroughs	see Table 4-4	Head/ Chief of boroughs *Jefe Delegacional*
State of Mexico	14,638,436	State Governor *Governador*
Municipalities	see Appendix A-3.1	Mayor *Presidente municipale*

Source: (Adapted from: INEGI, 2010a, 2010b; Ortega-Alcazar, 2006)

Though creating a single metropolitan government is considered unfeasible from a political stand point (Aguilar, et al., 2003), existing institutions at the metropolitan level have succeeded in establishing dialogue and in coordinating efforts towards solving specific metropolitan issues. This is the case of institutions such as the *Comisión Metropolitana de Transporte y Vialidad COMETRAVI*, the *Comisión Ambiental Metropolitana*, the *Comisión de Desarrollo Metropolitano*, and the *Secretaría de Desarrollo Metropolitano* which retain however their implementation competencies and independent budgets.(COMETRAVI, 2011a; Ortega-Alcazar, 2006; Secretaría de Desarrollo Metropolitano, 2007; Urban Age, 2006).

Transportation Challenges

Among the capital's pressing issues are urban transport and security (COMETRAVI, 2011b). These two concepts constitute the highest government expenditures in the Federal District for 2011, exceeding other concepts such as development and social welfare as well as ecology (Ciudad de México, 2011). The weekday traffic speed in inner-city road arteries average less than 10km/h in Mexico (Gwilliam, et al., 2004). Additionally a growing density of traffic flow is observed not only from the outskirt areas to the city center area but also between different sub-centers and in peripheral corridors. More than 5 million vehicular journeys are estimated daily with 44% thereof corresponding to commutes from the northern State of Mexico to the Federal District (Jordan et al., 2009). This long-distance commuting takes place in

two main forms: the use of private vehicles and mass transportation. Among the reasons why commuters spend one third of their journey in heavy congestion are:

(1) The increase in the number of private vehicles using a higher proportion of road space, given that road infrastructure in developing economies grows at a slower rate than vehicle ownership (Gwilliam, et al., 2004).
(2) The poor condition of streets in peripheral areas and the lack of value/access for collective and alternative transportation. As a result motorized traffic is a pressing issue in MCMA and has prompted since the 1950s the emergence of large scale transportation infrastructure mainly consisting in urban highways as well as the Mexican subway system inaugurated in 1967.

More recently, another stream of transportation projects comprising the construction of new pathways and the extension of public transportation through dedicated bus lanes was initiated. In 2006, the construction of elevated highways connecting a number of existing main roads in the Federal District was launched. These projects, perceived as extremely costly, may also possibly exert additional pressure on the natural environment especially with regard to air pollution. In addition, there are debates about who will be benefiting ultimately from this infrastructure: car-owning more affluent residents living in the west and south or lower-income groups. Regardless, these new mass transportation additions presuppose the transformation of the immediate urban surroundings and a significant alteration of the shape of the city.

With regard to mass transportation, the *Metrobús* BRT system currently comprising three lines and operating since 2005, is intended to incorporate new lines until 2012.[6] The system inspired by other similar BRT in Latin America, operates through a mix of organizations, in the form of a public-private partnership. The *Metrobús* is considered to perform well, reducing travel time by 33% on *Insurgentes* (Line 1) (Jordan, et al., 2009; Villarreal, Dávila, & Constantino, 2007).

[6] The BRT (Bus Rapid Transit) combines stations, vehicles (buses), and technology services in an integrated system and has several components such as dedicated lanes and busways completely separated from other traffic. For more information on the rapid bus transit system in the Federal District see http://www.metrobus.df.gob.mx/que_es_metrobus.html (Metrobús, 2011)

Housing challenges

The Mexican housing landscape has evolved since the 1950s. This can be observed in the way *vecindades*, a kind of tenement proper to a group of neighbors sharing a common dwelling estate, has been transformed in Downtown Mexico City. Nevertheless, the housing options and conditions for a large portion of the urban population remains a challenge in Mexico City. There is a need to supply housing for low-income dwellers without extending the limits of the city. Paradoxically one option is to reuse and recycle areas in Downtown Mexico City and to incorporate segregated settlements into the urban fabric. While some investors shifted their attention to supplying housing for middle income residents, self-help housing continues to pervade peripheral fringes as well as other parts of the city. "Wherever governments attempted to build houses for the poor they succeeded only in accommodating a minority. Given Latin American conditions, the formal building industry could keep up with the demands of the growing middle class, but never with the needs of the majority" (Gilbert, 1998: 81). This contributes to creating a greater discrepancy in the housing market as well as discrepancies in the socio-spatial character of the urban environment.

The question of housing is closely linked to the socio-economic nature of the local population and the question of equality of opportunities has been well documented and debated since the early 1950s. The changes generated by the Mexican revolution between 1911 and 1918, and subsequently, its economical (6% annual growth between 1940-1970) and demographic expansion did not manage to subdue the issues of class and opportunities in Mexico. Ward (2004: 42) suggests that the traditional colonial elites, who dominated the Mexican imperial landscape in the early 1900s, were merely substituted for other powerful groups during the post-

colonial era.[7] López Acevedo (2007) notes that most of the deterioration in the distribution of income happened in the middle to the late 1980s particularly between 1984 and 1989 with little change displayed in the 1990s. Although the trends in the distribution of earnings and education had shown some improvement by 1996, the poor who rely the most on labor as their source of revenue are the worst affected during economic recessions (López Acevedo, 2007). Low income urban groups spend most of their income on housing, transport and education. Housing represents the most valuable and vulnerable asset of low-income urban dwellers and plays a major role in the way that land is occupied in MCMA.

According to Puente (1999: 300), Mexico City presents characters of a "dual city". It features a core comprising the Federal District and the periphery made up of the remaining parts of the mega-city. This idea has been contested by those who consider the city as a poly-centric urban environment (Aguilar, et al., 2003) and which retains a heterogeneous nature with a mixture of socio-economic groups both concentrated and dispersed in all directions (Parnreiter, 2005). However, this research shows a perceivable difference between the structural conditions (housing and urban services) in the periphery of the Federal District. This is explained in part by housing policy frameworks, the types of housing demands and the differential growth at the core of the Federal District and on the northern edge of the State of Mexico. Housing units are therefore focal points where one can address the question of waste and consumption which, in the case of Mexico, differs depending on the socioeconomic background of urban dwellers and their settlements types. This is linked to lifestyle, waste habits and different consumption of goods making evident the differences between groups.

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[7]According to Ward, power is accumulated through regional development and/or through economic activity in different sectors. This differentiation has been widely discussed in theoretical attempts to conceptualize urban inequality (i.e. the emergence of segregation studies) in Latin American cities which date back to the 1950s (Lezama Lima, 1957). Over the last decades however, the range of explanations has become more diverse and more explicit in terms of development and sustainability.

4.2.2 Food waste management in the Federal District

Considering that the environmental impact of food waste management goes beyond the political jurisdictions of the Federal District, the management of food waste occurs under three regulatory frameworks: The Federal Law '*Ley general para la prevención y gestion integral de los residuos*', The Federal District local legislation '*Ley de Residuos Sólidos del Distrito Federal*' (Ciudad de México, 2004), as well as the Code for Biodiversity of the State of México, *Código para la biodiversidad del Estado de México* (Ciudad de México, 2004; SNIB, 2008). In 1999 it was estimated that 11,000 Mg. of municipal solid waste produced daily were transported in 2,011 waste collection vehicles to 13 transfer stations. After sorting, that waste was transferred to 236 large-capacity waste trucks. Approximately 35% of the waste was disposed of at two sites: *Bordo Poniente and Santa Catarina*. The rest was distributed to 1,200 waste dumps throughout MCMA (Kokusai Kyogo Co., 1999). A recent report suggests that 12,589 Mg. of MSW are produced daily from which 5,917 Mg. consist of household waste *Residuos Domiciliarios* (Ciudad de México, 2010). Solid waste generation per day per capita is estimated as 1.4 kg in the capital (Herrera Massieu, 2004).[8] The solid waste generation per borough estimated in 2006 is shown in Table 4-4. The highest generation was estimated for the eastern borough of *Iztapalapa*, which is a highly urbanized borough, and currently faces several urban issues such as lack of water supply and a high incidence of crime. The lowest waste generation rate was

[8] There are concerns regarding the total waste generation data reported by official sources. Official waste generation numbers have remained around 12.000 Mg. daily since 2004. Considering the rate of Mexico City's demographic growth, it is likely that the waste production in the Federal District is higher than stipulated. In addition, the official data stems from calculations which were provided by each borough without prior verification for accuracy and currency. Hence, there may be significant variations in official numbers. Secondary sources have estimated a total generation ranging between 18-25,000 Mg. (Mora Reyes, 2004). Further, estimations of 1.4 kg/d.ca of solid waste generation appear high, compared to the rate estimated in developed countries. It is unclear whether this calculation include other types of waste such as construction waste. Therefore, the rate of 1.4kg/d.ca is contested by international experts who consider that solid waste generation per capita in Mexico rather between 0.7-1kg/d.ca. Despite disparities and gaps in local estimations, the waste generation considered in this thesis uses data from government reports because these figures remain at large the data used by government officials to develop their programs.

estimated for Milpa Alta, which is the second largest yet least populated borough of the Federal District with a mountainous relief. *Milpa Alta* continues to retain a semi-rural character with a large portion declared as an ecological conservation area. (See the map of the delimitations of the Federal District to locate each borough in the Appendix A-3.2).

Table 4-4 Solid waste generation in the16 boroughs of the Federal District

No	Boroughs/*delegaciones*	Population in 2010 a)	Area km² b)	Solid waste generation Mg./da c)
1	Alvaro Obregón	727 034	96.03	628
2	Azcapotzalco	414 711	33.54	508
3	Benito Juárez	385 439	26.72	674
4	Coyoacán	620 416	54.03	791
5	Cuajimalpa de Morelos	186 391	70.73	169
6	Cuauhtémoc	531 831	32.69	1 296
7	Gustavo A. Madero	1 185 772	87.65	1 680
8	Iztacalco	384 326	23.21	461
9	Iztapalapa	1 815 786	113.45	2 208
10	Magdalena Contreras	239 086	73.51	245
11	Miguel Hidalgo	372 889	46.39	793
12	Milpa alta	130 582	288.13	110
13	Tlalpan	650 567	311.62	809
14	Tláhuac	360 265	85.91	341
15	Venustiano Carranza	430 978	33.77	865
16	Xochimilco	415 007	118.13	426
Total		**8 851 080**		**12 589**

Source: a) Censo de Población y Vivienda 2010, INEGI, 2010b; b) México En Cifras: Distrito Federal, INEGI, 2010c; c)Gobierno del Distrito Federal, 2006

Municipal solid waste is categorized into five main groups: household waste (including single and multi-dwelling units), commercial waste, services, controlled special waste and others. It was found that household food waste makes up 47% of the waste composition in residential units (Gobierno del Distrito Federal, 2010). Figure 4-3 shows the composition of the solid waste generated in the Federal District.

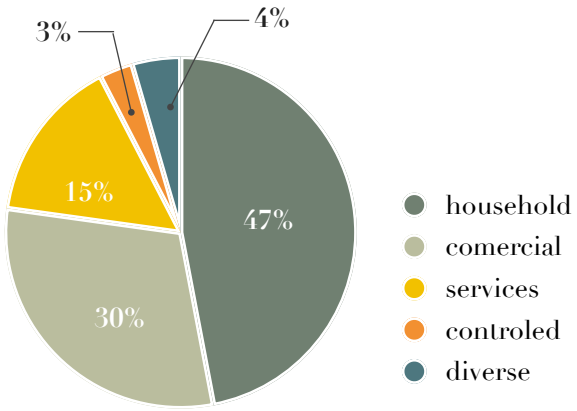

Figure 4-3 Composition of solid waste generation in the Federal District
Source: Gobierno del Distrito Federal, 2010

In 2012, the city's waste management infrastructure consisted of 20,000 employed workers, 13 transfer stations, three selection plants, six communal composting plants and one sanitary landfill - Bordo Poniente, IV stage (Cortinas, 2003; Gobierno del Distrito Federal, 2010). In addition, several open dumps have been closed and simultaneously 230 hectares of open spaces rehabilitated as green areas and/or parks. Since 2000, a number of programs have been launched with respect to solid waste selection, organic waste treatment, waste separation in schools and households. These programs and initiatives suggest that there is a significant potential for waste prevention and organic waste diversion. The flow of solid waste is illustrated in Figure 4-4. The waste generated from various sources and locations converges in different facilities where sorting occurs. These practices focus on the recovery of recyclable items and it is apparent that less attention is given to the organic fraction produced daily.

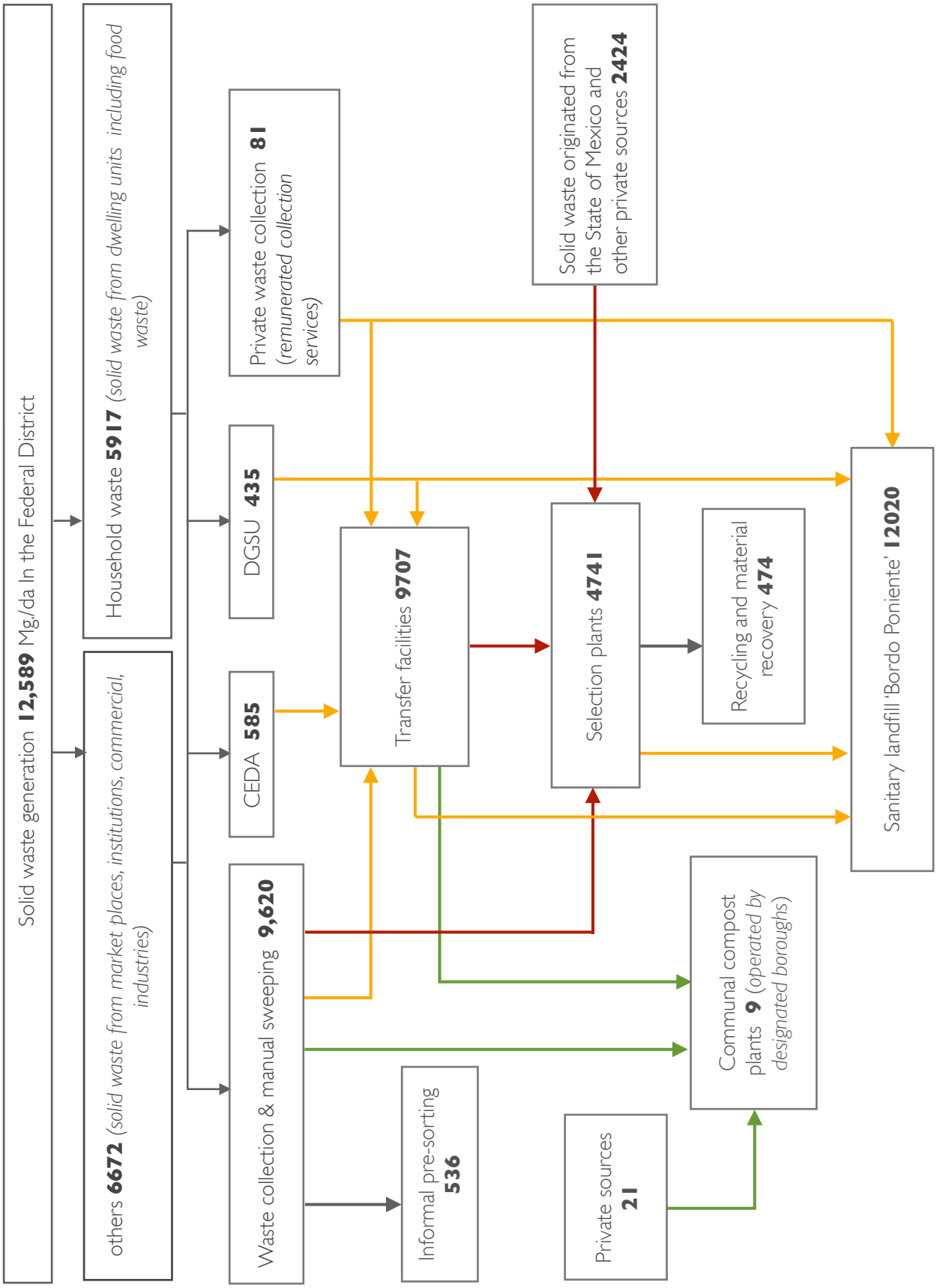

Figure 4-4 Waste management flow in the Federal District (the amount shown are in Mg. per day)
Source: *Gobierno del Distrito Federal-Secretaría de Medio Ambiente*, 2010

Figure 4-4 shows how only a small portion of the organic waste (mostly green waste from public open spaces) is being collected separately and treated in operating compost plants. The system remains largely one that is transfer-intensive, landfill-based and in which much of the food waste generated in households - which is amenable to composting - is disposed of in a facility that is known to have reached its life cycle.

As mentioned above, household waste separation into organic and inorganic fractions has been mandatory by law since 2003. Based on this law, initiatives such as '*Juntos pero no revueltos'*, and *'Escuela Verde'* were launched to foster changes both in residential areas and among formal and informal waste collectors (See Appendix A-4). While effort has been made to foster separation habits in the capital, separate collection remains a challenge. Figure 4-5 shows the trends of selective collection from 2004 until 2010. Indeed, according to these numbers solely over the last six years, only 7-13% of organic waste has been collected separately. There are few addition of routes since 2004 and the goals set by officials through the Integrated Solid Waste Management Program are perceived as difficult to reach (Wismer & Lopez de Alba Gomez, 2010). Food waste collection is a critical aspect of the current program. The most employed mode of waste collection is the 'corner method' where the waste collection vehicle takes position at a fixed collection point (usually at an intersection or at the corner of a street) and receives the waste from householders. Yet it is a service that is not fully considered and/or remunerated. At first glance, effective collection of organic waste depends on the extent to which ongoing waste separation programs are enforced and implemented and the willingness of the population to separate their waste at home. As it is the case in most Mexican cities, the responsibility of household waste collection remains under the lowest administrative unit jurisdiction. In the case of the Federal District each of the 16 boroughs' sanitary departments is responsible for the waste collection in their jurisdiction.

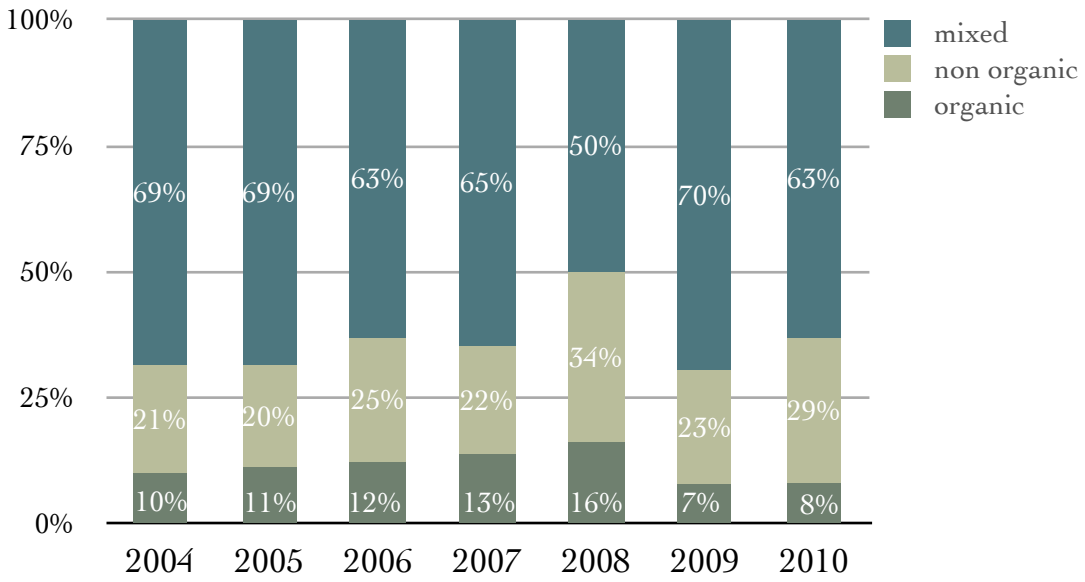

Figure 4-5 Percentage of household waste collected with source separation and separate waste collection in the Federal District

Source: Gobierno del Distrito Federal, 2010

Interviews with waste practitioners were triangulated with the review of evaluation reports to show that different factors affect collection activities. The main identified factors are:

(1) Collection routes lack efficiency and systematization
(2) The frequency of waste collection remains irregular in several localities
(3) More than half of the vehicle fleet (approximately 1087 vehicles) is estimated to have an average use of over 15 years which implies constant mechanical failures and high costs of repair
(4) Pre-sorting occurs simultaneously as waste collection which slows down collection activities and thus affects the waste collection coverage as shown in Figure 4-6
(5) The waste collection service incorporates informal street cleaners *barrenderos* (estimated at about 3,000 workers in 1999) as well as unofficial waste collectors (approximately 4,000 'volunteers' *voluntarios)* (Kokusai Kyogo Co., 1999)
(6) A syndicate holds control of the infrastructure, human resources, organization and operation of the collection and transport system of household waste in the Federal District

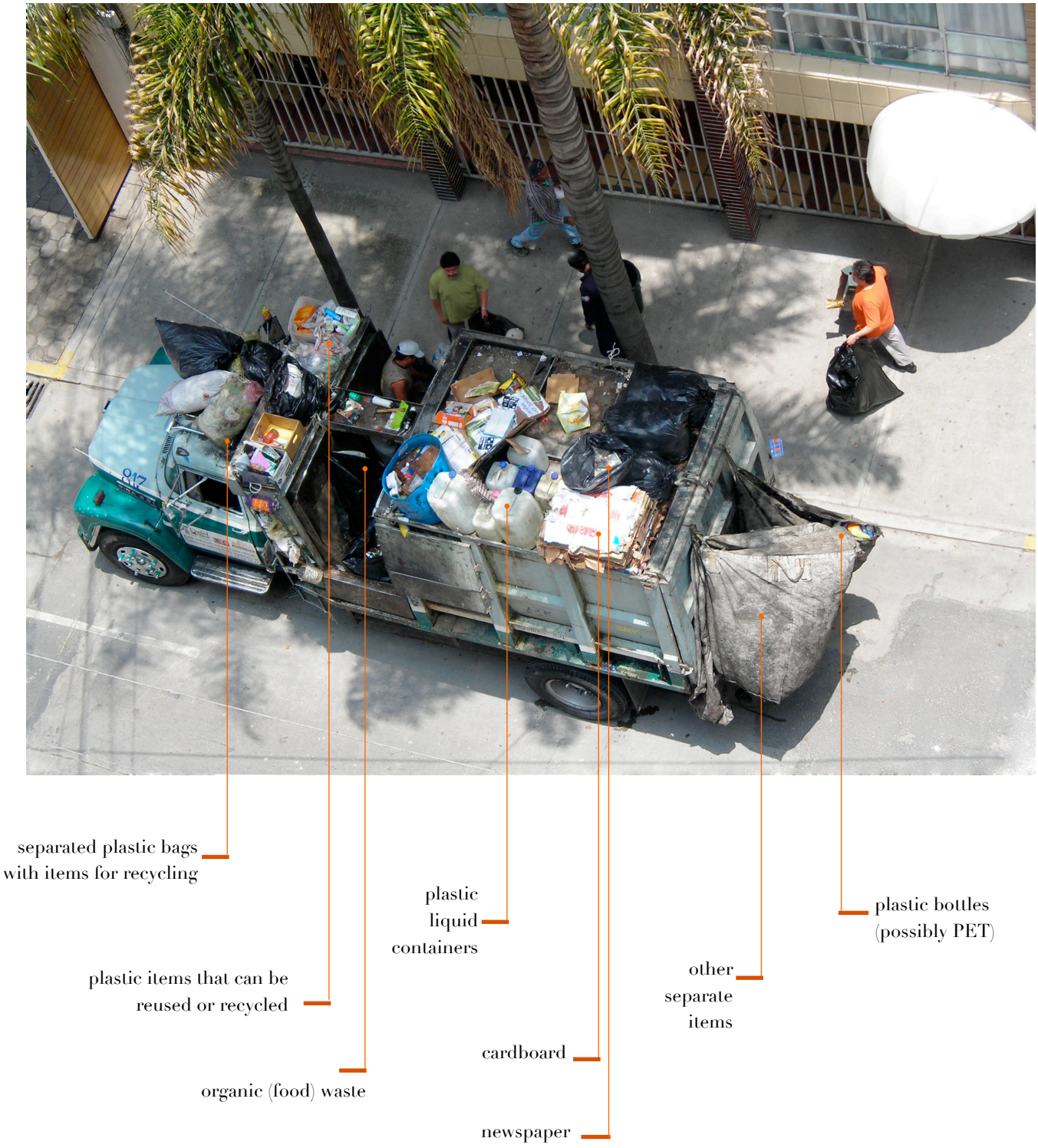

Figure 4-6 Mixed waste collection in the Federal District

Figure 4-6 illustrates a typical waste vehicle during collection day. Residents usually bring their waste to collectors who proceed to load the waste while sorting retrievable non-organic items. When mixed collection and pre-sorting occur, different waste storage systems can be observed inside most of waste vehicles. These activities are carried out simultaneously as waste is being collected and feature systematic selections of goods that will be traded to a recycling intermediary distributor at a later stage of the waste management process. The sorting arrangements observed during field trips in several boroughs of the Federal District vary depending on the vehicle, the workforce and the area serviced.

The informal sector is an important player in Mexico Federal District's recycling system as well as in the overall waste management practices in neighboring municipalities. It assumes urban sanitary responsibilities such as street cleaning and waste collection in many parts of the capital. As has been observed in other worldwide studies[9], the informal sector complements household waste collection in large urban areas and in some cases even substitutes them.

In the Federal District, informal workers collect and transport household waste from less affluent neighborhoods to specific transfer points by means of handcarts where they simultaneously apply their own separation and recycling system (i.e. preselecting cardboard, bottles, cans and other valuables discarded items before selling them to middlemen, bigger traders or to industrial companies). In certain areas, modern waste collection vehicles may not be able to reach residential units due to street design and difficult access, particularly on the Federal District's periphery. Smaller vehicles or more simple pushcarts used by the informal sector

[9] Informality in municipal waste management in Mexico stems from processes of urban growth, migration and industrialization in which the demand for urban services exceeds the capacity of local authorities. In addition, the low level of taxation in urban services, presupposes a lack of financial resources for the local government to meet the urban demand. Informal services have high earning opportunities for unskilled workers and are estimated to be 2/3 of the labor force in the sector's activities. For more details on informal waste management system see: (Buenrostro et al., 2001; Medina, 2005; Nas, & Jaffe, 2004)

have been proven more effective to service remote areas despite their limitation in the volume of waste handled.

While the coverage of waste collection is inferior to other services such as energy and water supply in many localities in MCMA, the labor force in the Federal District is robust and comprises a mixed group of formal and informal actors that interact within a larger environmental policy agenda. A well-defined command structure is lacking and this is evident through the duplication of institutional efforts as well as uncertainties in official terminology and data. The composition of solid waste shows a large portion of organic waste produced in the capital, yet the potential for transforming organic waste into a valuable product has not been fully explored by local authorities. There is a potential for food waste recycling, which requires improving collection methods and fostering waste separation at the source. Decentralized food waste management processes have the potential to reduce the volume of waste disposed in the unique operating landfill known to date.

4.3 Conceptual framework summary

In Chapter 2 a link between the scale of waste issues at global, national, local and individual levels is shown through the reviewed literature predominantly from the environmental sciences with a particular focus on infrastructure and social sciences. A model integrating most recurrent constructs was proposed. It incorporates global concepts such as consumption, recycling, and waste separation with divergent national discourses in both developing and industrial territories with more local concerns such as waste education, health and ideas on the ethic and habits of waste at an individual level. Such a model does not attempt to be exhaustive; rather it highlights specific trends stemming from multidisciplinary enquiries proper to the urban context that play a particular role in waste management processes. It was shown that there is a perceived necessity to draw from local knowledge and creativity to solve problems related to organic waste management.

In recent years, organic waste has taken a more prominent position in environmental debates given the increasing depletion of natural resources, the demand for renewable resources in the industrial and emergent world, the effect of uncontrolled organic waste management in less wealthy communities and the problems of nutrients and soil degradation in urban and rural areas. From green yard cuttings, to manure product, to paper sludge to food waste there are few forms of organic waste that cannot be treated for reuse in urban agriculture. Food waste which is conceptualized and explained in Chapter 3 accounts for a large portion of the organic waste produced in cities. From the perspective of peri-urban agriculture, food waste processed into compost represents a valuable fertilizer. Amongst the various values of composting is the ability to intensify plant production typical for urban and peri-urban agriculture such as crops and vegetable cultivation. It also contributes to the reduction of the volume of waste disposed in open dumps and sanitary landfills. Questions remain in relation to the introduction of a system for food waste separation at the source, for separate collection and how successful a potential reorientation of urban waste management can be in a particular urban context.

Chapter 4 introduces how food waste management unfolds in the Mexico City Metropolitan Area in which the all too often shortcomings in collection and final disposal arrangements are broadcast in local journals. Analyzing the complex culture of waste management in the Mexican capital implies first and foremost understanding the causes of the leapfrog expansion of Mexico City's metropolitan boundaries in which three main features can be considered:

- The anthropogenic form of land use manifested through sprawled and heterogeneous building structure
- The altered form of land cover specially perceivable in road and infrastructure
- The impact on urban ecosystem processes through uncontrolled waste management practices

In addition, the informal sector which has been present for more than 60 years and which over time has grown to a semi-organized enterprise, plays an important role in the potential that exists to transform organic waste into a valuable end-product with considerable benefits for sustainable urban development. Informal workers are not isolated actors they are embedded in a larger society that holds the key to a more healthier environment in relation to waste production and disposal in households.

The following chapters (Chapter 5 and Chapter 6) deal with searching the evidence with regard to food waste composition, and separation habits at household levels. They make up the empirical part of this dissertation as they expose the research design and the fieldwork conducted between 2007 and 2010. The next two chapters focus on the process of developing and systematizing results obtained from field assignments conducted in Mexico. These findings were obtained from in-depth investigation at a household level in different urban contexts, and working closely with individuals from different backgrounds.

These chapters are a central component of this dissertation. They complement general ideas presented in previous chapters by investigating the urban context and built structure of different housing units. The empirical work of this study offers insight on what occurs in the "real world" and contributes to making sense of the daily practices of food waste management in MCMA. The tools developed and applied progressively to collect food waste data with participants form a significant part of the whole research study. They offer a unique mélange of instruments to investigate the food waste production of a purposive sample of households and help test the existing status of food waste.

Until 2012 there were little research which explores the methodology for determining food waste at household levels in Mexico. The existing research on waste composition in Mexico, discusses for the most part the type of waste that ends up in sanitary landfills rather than the solid waste produced in different urban streams. The next chapter spells out the challenges faced with developing a methodological strategy that not only contends with an under-researched topic such

as food waste but also uses participatory tools to present participants' own perceptions of their daily waste practices. The chapter exposes the methodological strategy designed specifically to involve people in the collection of data and which allowed them to participate in the research design. Factors explained include the design of the study, the participants involved and what they did, as well as the measures that were used. This is a substantial segment of this dissertation that has the main purpose to present the habits, awareness and perceptions of individuals about the problems of waste in their urban environment and to provide raw data about the amount of waste produced in different homes.

Given that the amount of food waste produced in urban settlements is not well known and continues to produce large debates among experts and engaged stakeholders, the empirical segment of this dissertation offers data collected on food waste production at the source - i.e. at household levels. This represents the first stage of research to systematize qualitative and quantitative food waste data obtained at local levels in the Mexico City Metropolitan Area.

5. Tool development to measure food waste from residential dwellings

Chapter 5 presents the research's methodological strategy. It relates to the development of three tools of measurement and highlights a set of indicators measuring both social and spatial determinants of waste production and collection. This chapter provides a description of a questionnaire, a food waste diary and a weighing record system developed to investigate food waste production at the household level. It also stresses the collaborative knowledge process undertaken to integrate the narrative of individuals, their habits and beliefs about waste and their environment.

5.1 Data collection Strategy

To appropriately answer the research question on how food waste disposal practices take place in *residential dwellings*, a data collection strategy which integrates three different household food waste assessment tools was developed.[1] The tools include (1) A *Household Based Questionnaire* which aimed at exploring determinant factors of the urban local context; (2) A *Food Waste Diary* which focussed on the food waste composition and daily practices of waste storage at household levels; and (3) A *Weighing Recording System* which provided the weight and volume of food waste produced inside residential units which were studied for the purpose of this research.

The strategy considered four central aspects within the research design:

(1) The role of participants

(2) The attention to local urban context

(3) The use of mixed methods

(4) The gradual development of research tools

Role of participants

The role of participants in the collection of data was considered crucial. This follows the idea expressed by Action Research scholars who regard co-generation of knowledge as fundamental in explaining lived reality and in building upon

[1] The data collection strategy encompasses the overall plan of action designed to collect and analyze the data. The tools that were developed are considered as instruments for discovering or measuring facts and aimed at responding to research questions RQ-2 and RQ-3. The tools include a questionnaire, a waste diary and a weighing recording system, each of which differs from standard methods for assessing household waste composition (e.g. ASTM D5231: was the standard used to define and report the composition of MSW through the selection and manual sorting of waste samples); in turn these tools take into account anthropogenic factors - at the household and neighborhood levels - that play a role in the way that food waste is produced, stored and managed (ASTM International, 2008).

established knowledge claims (Greenwood & Levin, 2007). It also relates to the concept that context-centered data can only be obtained by narrowing the distance between science and practice (Fals Borda, 1995). Integrating the collaborative effort of a community or group of individuals and the skills of a researcher to foster some kind of social change stem from the desire to integrate theory and practice and to narrow the gap between what is often proposed conceptually and what occurs in daily life. With that in mind, the research was designed to allow participants to take an active role in the generation of data - particularly in information related to the way that food waste is generated in their homes. A modality of co-generation of information was established with the purpose of fostering some kind of change in domestic waste habits and to help generate reflections on possible behavior adjustments in regard to food waste management.

Attention to the local urban context

Attention was given to building the tools into the local context. This follows the idea of "communicating context-centered knowledge" in a way that is "understandable" to others facing "comparable but not identical" situations (Greenwood and Levin, 2005:54). Hence, by contextualizing the tools in the locations in which they were applied, the body of knowledge co-produced with residents is grounded raw data that may help to paint a clear picture to those concerned with attitudes and habits towards food waste and environmental behavior.

Mixed methods

The use of mixed methods i.e. combining naturalistic qualitative approaches and descriptive quantitative techniques was adopted to collect and analyze the data (Creswell, 2009; Maxcy, 2003; Tashakkori & Teddlie, 2003). Some waste problems addressed at a household level presented a complex structure which required several layers of explanations. A combination of research techniques helped both explore and to explain waste facts and to incorporate the notion of 'triangulation of

information' (Tashakkori & Teddlie, 2003). The specific combination of techniques used included a questionnaire + a diary + weighing recording system + observations.

The quantitative tools offered a pluralism of inquiry that strengthened the qualitative variant prevalent throughout the research. The blend of techniques aimed at widening possible interpretations about how groups of individuals dispose of their waste in their homes. Quantitative data obtained from the questionnaire and the weighing record exercise blended with qualitative procedures such as the food waste diary and focus group discussions and together offered a continuum of reflection. The quantitative measuring techniques used in this research help generate standard information on food waste composition and weight. There is insight to be gained from a descriptive analysis of the social characteristics of the group of individuals who participated in the study in connection with the type of waste they produce and their physical urban context.

Explanations of the urban context emerged from numerous conversations with local experts and observation protocols. Different perspectives and reflections on the development of the urban context were not only retrieved from a collection of interpretative sources but emerged from two field trips conducted in several locations in the *Zona Metropolitana de la Ciudad de México* and the municipality of *Jiutepec* in the state of *Morelos* from 2007 until 2010.

The qualitative tendency which prevails in the research design stems from the voices of participants. Their views, attitudes and habits with relation to waste are placed at the forefront of the data collected to highlight the opinion of people in regard to the problem of waste in their environment. Another influencing factor for leaning towards a qualitative appraisal was the nature of the literature available in and about Mexico. Both local primary and secondary sources related to Mexico City's social and spatial conditions draw heavily on qualitative socio-economic findings (Kandell, 1988; Molina & Molina, 2002; Ramírez Kuri, 2009; Ward, 2004). The development of ideas related to Latin American societies and particularly to the socio-political culture in Mexico has increased steadily since the 1950s. Hence, the landscape of

printed documents reviewed in local bookshops, libraries, online catalogues and in Mexican universities is extensive and suggests a substantial production of knowledge in the historical, social and cultural experiences of Mexico which were measured against results obtained from empirical work in natural settings. The interaction between what is written about food waste, society and the urban environment and what people say about their food waste habits and their perception of urban waste management pervades this dissertation in a qualitative explorative form.

Another aspect of the qualitative nature of this research is the method used for data collection. According to Creswell (2009), collecting data where the phenomenon occurs and interacting with people are inherent characteristics of qualitative research. During the research, in some cases the data collected involved an 'up close and personal' interaction with participants. For instance, during the field trip in Mexico City from July to September 2009 a more interactive collaboration with participants was established. The length of communication and exchange with participants varied between seven to 15 days and included repeated telephone calls and visits. Conversations about waste conducted in participants' homes, were undertaken in 'a participant observation setting' allowing respondents to speak freely and openly. These forms of exchange were helpful in gaining participants' trust and in understanding their way of seeing waste problems, their local situation and context.

Gradual development of research tools

The research tools were designed to be improved as the research progressed: field work and critical reflection were alternated allowing a level of flexibility in the procedures of data collection. Focus was given to 'what works' rather than to preserving the intactness of the procedures developed to expose food waste and habits of waste disposal. As the problems of food waste management in specific locations became more evident, and the question about the composition of food waste continued to arise, it became clear that a gradual refinement of questions was

necessary. In addition, between 2007 and 2009, international discussions about food waste, particularly in the UK and Australia became more pronounced.[2] New publications on food waste assessment offered a possibility to review the formulation of preliminary questions and to reflect on successful and failed assessment approaches.

The concerns for collecting food waste data at a household level stemmed from the need to highlight the multiple factors that may influence food waste production at the source. It is important to consider that any inquiries dealing with people and the environment in which they interact, requires a certain level of contextualization which becomes disproportional at a larger scale (e.g. cities, regions). An inductive waste management assessment at a household level may offer signs that are not easily perceivable at a city scale and allows for better local framing. This approach is open-ended by nature and draws on circumstantial facts and differs from other food waste composition studies.

The methodology proposed is based on self-measurement perspectives which require the goodwill of participants and is time consuming. It also carries some disadvantages in terms of objectivity and accuracy as it relies on the criteria of others. Another observation is that it supports individual approaches and considerations which can make it difficult to replicate the study. These weaknesses were taken into account and were dealt with in pilot studies. The most important consideration was to engage others in the study and to collaboratively workout the challenges of producing contextual local knowledge.

[2] Among other studies are a series on food waste conducted in the UK especially a recent report together with the World Wildlife Fund (Chapagain & James, 2011) and reports on consumption and waste as well as household expenditure in Australia (Baker, Fear, & Denniss, 2009; Morgan, 2009).

5.2 Research empirical approach

There were three main phases in the research's empirical approach. These phases are summarized in Table 5-1. Phase 1 took place in 2007 and includes initial explorative inquiries on the effectiveness of household waste collection from the perspective of practitioners and householders (see Appendix A-5.1). This was followed by the development of the research methods and the refinements of the research tools in 2008 and 2009. Throughout this period, a questionnaire -which served more as a tool for a structured interview- and waste diary were developed and tested separately in pilot studies in Australia (see Appendix A-6.1). During 2008 the tools were tested in different household settings, each application offered a chance to capture valuable lessons from engaged participants. A first pilot study was conducted with 26 households in Sydney, Australia followed by a smaller sample of four households in Weimar, Germany which focused mostly on contextualizing the tools to the Latin American context (see Appendix 7.1). The pilot tests in Sydney and in Germany were conducted with the following intentions:

(1) to test and improve the tools as the research progressed

(2) to examine the relevance and level of transferability of the research design

(3) to measure the willingness of participants to take a more active role in measuring the waste they produce

During the second half of 2009, the focus of the research turned towards the Latin American context where the lessons learned from the pilot studies were applied in Mexico. Between June and August of that year, the composition of food waste in Mexican households was investigated in depth with a sample of 30 households. Preliminary analysis was conducted in 2010 and validation, which included ongoing tests and continued contact with participants, continued until early 2011.

Table 5-1 Empirical research approach

Period	Sample Number	Description	Location
phase 1 explorative inquiry which included consultation with experts as well as focus group session (2007)	28	interview with waste practitioners, informal talk with waste educators, contact with NGO and CBO agents	Jiutepec
	25	interactive exchange of ideas with female participants on the question of waste in their local context.	Jiutepec
phase 2 methodological inquiries, development of tools, tests and empirical work (2008-2010)	26	lecture and Food Waste Diary exercise at the University of Sydney, Australia. (DAAE2002 Architecture, Place and Society-"Interventions about People, Place and Waste" A/Prof Anna Rubbo lecturer)	Sydney
	4	pilot study with Latin American households to test the relevance of the tools in a Spanish speaking context	Weimar
	30	field study tools application with mixed household types in urban and peri-urban areas	Mexico City & Jiutepec
phase 3 further tests and validation, analysis (2010-2011)		observation of urban context, descriptive data analysis, generation of matrices and correlation of data	Mexico City, Sydney & Germany

Purposive sample

The tools mostly accentuate the data of the chosen population based on a purposive sampling rationale.[3] This is a sample selected in a deliberate and non-random manner to achieve a certain goal, as opposed to random and representative sampling. As the research developed, it became obvious that the question of food waste generation in the domestic sphere was, to some extent, a private matter. In order to gain access to people's homes and to observe their food waste behavior, the use of social connections and the building of trust were necessary. Food waste study in homes is a delicate matter in the case of Mexico. Those who participated in the

[3] Purposive sampling considers different ranges of data and helps originate grounded theory that takes into account local values and conditions. For more purposive selection techniques see: (Quinn Patton, 1990; Teddlie & Tashakkori, 2009).

research were selected with the goal of providing a descriptive account of different types of household settings as well as different types of waste management systems in different urban environments.

As illustrated in Figure 5-1, the sample included four types of participants: 1) household occupants, 2) key individuals (i.e. waste practitioners, waste educators, NGO and CBO agents), 3) collaborators from local government and 4) a group of women who raised their opinions on household waste practices in a focus group session. The empirical work was conducted in distinct geographical locations: Australia, Germany and Mexico. The work done in Sydney and Weimar served as pilot studies. The main field work was subsequently conducted in Mexico. During the summer of 2007, several reconnaissance exercises were conducted in Jiutepec.[4] The objective was to map relevant local institutions in regard to waste management and to test the effectiveness of in-depth household-based assessments. This dissertation focuses on the results from Mexico obtained between 2007 and 2011.

The orange number "25" in the map (Figure 5-1) indicates the number of participants who took part in the focus group session in Jiutepec in 2007. The session was undertaken with 25 female participants who shared their ideas on the context of food waste management in Jiutepec. Primarily the session aimed at exploring the role that household waste disposal plays in local waste management through the opinions and voices of locals. The grey number "28" on Figure 5-1 signals the number of experts and practitioners who were consulted during early explorative contextual inquiries (see Appendix A-5.1). The red numbers "30", "4" and "26 show the households which were investigated between 2008 and 2011. In Mexico a total of 30 households were studied in several locations within the Metropolitan Area of Ciudad de México particularly in the Federal District *Distrito Federal,* and the City of Jiutepec. Finally, the blue digit "5" indicates the number of collaborators

[4] (See Master's thesis: Jean-Baptiste, 2008b)

from local government who applied the tools in specific projects conducted in Sydney in 2010.

Figure 5-1 Overview of purposive sampling

Despite the fact that the research was conducted and reflected upon in different geographical settings, it was never intended as a comparative study and can never be considered as such. Household food waste has an endemic nature which is associated to contextual socio-economic conditions that vary over time from one location to another. Therefore the ideas of contextualizing the tools to assess waste composition and the disposal practices that affect waste management remained at the forefront of the research design despite its international application. Between the experiences and lessons learned from pilot tests conducted in Australia, focus group sessions and study tests conducted in Mexico and remote monitoring conducted in Germany there was much to learn. However, to pin-point a specific regulatory framework, it became necessary to focus on one location, which in this case is Mexico. Therefore the findings of the trial in Sydney are not included in this dissertation.

5.3 Development of tools of measurement

Much of the inspiration for introducing different tools comes from the rationale that valid answers related to food waste management need not be essentially drawn from traditional assessments of the mean composition of MSW. Hence, the formulation of questions in the questionnaire stemmed from a people-centered approach that focused on connecting the views of different groups, their household and building structure as well as their food waste practices. A core set of 20 indicators was developed along four main themes. The indicators served as signs that helped to pin-point certain characteristics of the immediate urban context and were used to guide the type of questions or data necessary to better understand the endo- and exo-determinants of food waste. Table 5-2 summarizes the themes, indicators and preliminary questions that were formulated within the development of the questionnaire

Table 5-2 Set of contextual indicators to food waste management in an urban environment

Theme	Nr	Indicator	Description
Household structure	1	Household size	Q: How many people live in your home?
			Indicates the number of occupants living together in the house
	2	Level of school attendance	Q: What is the highest qualification completed by anyone in the house?
			Indicates the level of school attendance or number of years of school
	3	Household composition	Q: What is your marital structure? Q: Are there children/senior in the household?
			Indicates the relationship structure of the occupants in the household
Housing Characteristics		Settlement type	Indicates the type of area (urban/ peri-urban/ rural) within which the dwelling is located
	4	Dwelling/ housing type	Indicates the building type (free standing/ apartment building/ floor distribution) as well as the type of construction and building material used

Theme	Nr	Indicator	Description
	5	Ownership and property title	Indicates the degree of comfort and safety of a household derive from ownership and determines the type of rights that occupants have
	6	Access to electricity supply	Q: What is type of lighting does your household use?
			Indicates the accessibility or mechanisms to obtain electricity using communal grid or other energy supply options
	7	Access to water supply	Q: What is the primary source of water for your house?
			Indicates the type of water provision services available for the household
	8	Level of sanitation	Q: What type of sanitary services does your household use?
			Indicates the existence of municipal sewage system, septic tanks or latrines in the household
	9	length of residence	Q: How long have you lived in your home?
			indicates the number of years occupants have lived in the dwelling unit
Food Waste	10	Food consumption patterns	Q: What type of meal do you usually share with others? Q: What is a typical meal experience in your home?
			Indicates the typical food experience that describe each occupants and also the type of meal that is usually shared in the household. It provide a clue on the degree to which food and food waste is produced
	11	Food waste habits	Q: How much of the food you purchase is packaged or in a plastic container? Q: Is too much food prepared in the household?
			Indicates the amount of packaging resulting from food purchase and the degree to which food is wasted in the household
	12	Food waste separation	Q: Do you separate your food waste from other type of waste?
			Indicates the degree to which organic or biodegradable items are separated from and non organic waste in the household
	13	Compost experience	Q: Do you compost?
			indicates occurrence of composting in the household

Theme	Nr	Indicator	Description
Sense of community	16	Level of social network	Q: Are you a member of a community organization?
			Indicates the affiliation to an organization by occupants of the household
	17	Degree of collective action/ participation	Q: how is the spirit of participation in your community?
			Indicates the degree to which there is cohesion between residents
	18	level of trust	Q: Do you feel people in your neighborhood are basically honest and can be trusted?
			Indicates the level of trust extended to neighbors and other people in the local community
	19	transportation	Q: What type of transportation do you mostly use? Q: Is there public transport in your neighborhood? Q: How well is your street connected to main avenues/ roads?
			Indicates the type and availability of personal and public transportation modes
	20	communal prosperity	Q: Are there people who came to work where you live? Q: Has the availability of employment, roads, housing, safety, environment improved, worsened or remained the same?
			Indicates the degree to which communal prosperity is perceived in the immediate context

5.3.1 Household based questionnaire

The questionnaire emerged from the work conducted in Mexico in the summer of 2007, which aimed at exploring the connection between people, the organic waste they produce and their cultural context.[5] During the early stages of the questionnaire's development, the focus was to explore waste management practices in the State of Morelos, particularly in Jiutepec (Jean-Baptiste, 2008a). Hence, the

[5] Some questions included in the questionnaire were drawn from an instrument of social capital assessment tool at household level (SOCAT) published by the World Bank (World Bank, 2012).

questionnaire was developed as an initial tool that provided a brief insight into the composition and volume of food waste produced in residential units. The questionnaire's focus was to test the extent to which waste management could influence the ecological conditions of the urban environment. The questions revolved around three main themes: waste separation, home composting and household habits.

During the course of 2007 and 2008, the questionnaire took the form of a living document which was continually edited and updated. At the end of 2008 it ultimately evolved towards a household based document that placed more emphasis on the *context* in which participants produced their waste. By the time it was applied in Mexico in 2009, the questionnaire took the form of a semi-closed format with multiple choice questions concentrating particularly on measurable data on social, physical and behavioral determinants as well as attitudes that influence waste production in the domestic sphere. This mixed instrument offered the possibility to collect both structural and cognitive data, which helps to explain some reasoning behind certain environmental actions. In this case, what guided the construction of questions was a desire to find out to what extent the context played a role in waste separation habits and in-situ disposal.

In Mexico for instance, participants were asked to fill in a structured questionnaire which included 65 questions covering the four main themes structured in Table 5-2: Household structure, housing characteristics, food waste and sense of community. The objective of the questionnaire was to collect data at a household level that would enable the identification of endo- and exo- socio-cultural and contextual determinants of food waste production (see Appendix A-6.2). The results of the questionnaire are discussed in Chapter 6 and are mostly confined to Mexico City;

and Jiutepec; however the questionnaire was tested and applied in other geographical locations as well as in other cultural and socio-economic backgrounds.[6]

The questionnaire was developed and implemented in three distinct phases over the course of several months between 2008 until the beginning of 2009. Questions were added and/or removed based on the answers provided by a core set of 13 respondents during a reconnaissance period in Sydney and Germany before its application in Mexico. The questionnaire was then translated into Spanish and applied to 30 household cases in Mexico where respondents completed it in the presence of a surveyor who provided an opportunity to clarify any questions. Notes were also taken.

The questionnaire design was never intended to survey a large sample. It was always recognized that this particular questionnaire would serve as a quantitative standardized interview that would investigate a series of contextual themes hypothetically interconnected with food waste management. This quantitative tool would then highlight identified waste management practices that are more sustainable.

The questionnaire's first main theme is 'Household Structure'. It dealt with the household's attributes such as the number of occupants, the household education level, age of occupants as well as the existence of children and elderly people in the household. Questions about income/expenditure were not included. During reconnaissance tests, such questions seemed to cause uneasiness to respondents and were subsequently dropped from the questionnaire.

The second theme, 'Housing Characteristics', is related to the dwelling's physical condition. Figure 5-2 illustrates the types of questions asked which included location

[6] For more details on the results of the tool application in Sydney, see the conference proceedings titled 'Using a Food Waste Diary to Impact Food Waste Reduction in Sydney's Eastern Suburbs' (Jean-Baptiste, Michener, & Wilson, 2011, from: http://www.ewmce.com/library/2011-conference-proceedings)

(i.e. address), house type (i.e. free standing house, apartments), home ownership situation as well as questions on water, energy supply and sanitary services.

Questionnaire Pilot Study - Sydney 2009 No.QPS/

Housing characteristics

Questionnaire - date:
Start_____ End_____

Dwelling Type (DT)

1. province/state

2. City

3. Neighborhood/area

4. Type of area

- urban
- rural
- indigenous
- difficult access

4. Name of the street

5. What is your house type?

house
- free standing
- attached town house

apartment/units
- with lift
- without lift

floor distribution
- 1 storey
- 3 storey
- 2 storey
- more

other features
- garden
- pool
- garage

6. How many bedrooms?
# of bedrooms

7. Your home is:
- owned
- rented
- given in exchange of services
- squatter
- don't know

8. What construction material is used for the majority of the house?

roof

walls

floor

Water, energy supply & other services (WES)

1. What is the primary source of water for your house?
- piped water system
- open tap or faucet
- private /public well

2. What type of lighting does your household use?
- electricity / public source
- electricity / private source
- other, specify

3. What type of sanitary services does your household use?
- sewage system
- septic tank
- latrine

4. Are the streets in your neighbourhood swept periodically?
- yes , frequently
- yes, rarely
- no

5. How long have you lived in your home?

6. Have you made any repairments or improvements in your home during the past years?
- yes
- no

if yes, indicat what type:

[1]

Figure 5-2 A segment of the questionnaire on the contextual attributes to food waste

In the questionnaire, a genogram was included.[7] It facilitated an understanding of the family structure or existing relationships in the household. The intention was to create yet another opportunity to interact with participants. They were asked to draw their household composition by using a set of predetermined symbols that represented family members. This exercise not only served as an awareness trigger to reinforce the fact that each informant belonged to a larger household context but also helped triangulate each household statement in the tool.

The third theme is related to 'Food Waste'. Questions with regard to household food consumption (i.e. types of meals, food purchasing habits, the person responsible for food preparation) and separation habits (i.e. number of waste bins, food storage space) were included.

The last theme dealt with the 'Sense of Community'. It focused particularly on the sense of engagement and the horizontal association between informants and the community within which they interact (World Bank, 2010). Questions focused on length of residency, spirit of participation, membership in community based organizations and neighborhood perception. The latter concentrated on the direction of respondents' attitude and beliefs as opposed to the intensity of their position. Questions about mobility and street life as well as the perceptions of community prosperity were also asked. They included for instance transportation modes, street features, green areas, safety and changes in the neighborhood's urban environment during the last three years.

[7] A genogram is a visual display of a person's family structure, hereditary. Developed by Mac Goldrick and Gerson in the 1980s, they now serve as a tool that highlights family relationships in different fields of work ranging from medicine to education (McGoldrick, Gerson, & Shellenberger, 1985; Rigazio-DiGilio, et al., 2005).

5.3.2 Food waste diary

The food waste diary designed for the purpose of examining the type of waste produced in residential areas follows principles of a structured diary, which is generally referred to as a booklet that contains a series of questions to be answered over a period of time.[8] A structured diary features sections covering events for at least seven days. Typically respondents are asked to complete a segment at regular intervals normally once a day for a week or two (DeLongis, Hemphill, & Lehman, 1992). The distinction between the structured diary and other types of diaries is that participants provide answers using a standard format that is repeated for the duration of the data collection period. A structured diary leaves little room for personal narratives although in some cases a note section may be provided for that purpose.

The concern with diary techniques applied in food waste studies is how to manage subjectivity issues in the data collection. Current discussions in the international community show a concern for accuracy, comparability and reproductivity of methods. This particular study is mostly concerned with revealing the food waste data obtained from households in a context where very little information is available about food waste at the source. Accuracy issues were managed through communication, monitoring and triangulation.

Figure 5-3 illustrates a section of the food waste diary developed and applied in a pilot study in Sydney. The layout contained seven sections for seven days and was conceptualized for self completion within an average period of three minutes per section. The diary included a sample which illustrated the correct way to fill it in.

[8] It is important not to confuse the food waste diary with a personal journal or notebook containing events and intimate feelings normally intended to remain private. The meaning of the word 'diary' in this dissertation stems from the Latin expression 'Diarum' meaning 'Daily Allowance'. The term is closer to what is understood as a 'daily record', 'log' or 'self-report sheet' used to provide information on a day to day basis. Scholars concerned with the diary as a method, note that it provides an opportunity to assess events in their 'spontaneous context' It is viewed as a good tool to address questions regarding processes and change (Bolger, Davis, & Rafaeli, 2003)


Pilot Study - Sydney, 2009 No.DPS/

Food Waste Diary SAMPLE - date: 12/02/2009

1.What type of meal did you have at home?
breakfast ☐ lunch ☐ dinner ☑

2. How many people shared your meal? 2
(if you ate alone write down zero)

3. Please select the type of food waste that describe best what you threw away during that meal
spoiled/excess cooked food ☑ vegetable/fruit peelings ☐ beverage ☐ raw food ☐ meat scraps ☐ nothing ☐

4. Food description (Name 5 food waste items you threw away. Please indicate with an arrrow the waste bin you used for each item.
nothing ☐
1. bones
2. salad
3. rest of rice
4. old cheese
5. soda
1.general bin
2.kitchen sewage
3.separate organic bin
4.compost bin

Food Waste Diary Day 1 - date:

1. What type of meal did you have at home?
breakfast ☐ lunch ☐ dinner ☐

2. How many people shared your meal?
(if you ate alone write down zero)

3. Please select the type of food waste that describe best what you threw away during that meal
spoiled/excess cooked food ☐ vegetable/fruit peelings ☐ beverage ☐ raw food ☐ meat scraps ☐ nothing ☐

4. Food description (Name 5 food waste items you threw away. Please indicate with an arrow the waste bin you used for each item. SEE SAMPLE!)
nothing ☐
1.
2.
3.
4.
5.
1.general bin
2.kitchen sewage
3.separate organic bin
4.compost bin

[3]

Figure 5-3 A segment of the food waste diary applied in a pilot study in Sydney

The food waste diary was presented to participants in a brochure format including detailed instructions on how to complete each section. As in the case of the questionnaire, the food waste diary was applied in several types of homes that had different household structures in distinct geographical contexts. Pilot tests were

undertaken between 2008 and 2009 in Sydney and Germany followed by more context-centered applications in Mexico City and in the city of Jiutepec between 2009 and 2010. The food waste diary aimed at reporting exclusively food substances that were discarded in both single and multi-units residential dwellings. The diary served as a household descriptive report of food waste patterns and was designed to record events related to waste composition and waste storage. Although participants were encouraged to comment on their wastage habits, the diary placed more emphasis on the type of food waste produced every day rather than the way in which that waste was produced.

The food waste diary was conceptualized as a tool to record chronological events related to eating habits, food waste and patterns of food waste storage in homes. This diary aimed at gaining an insight into when and what participants ate as well as what type of food waste they produced. Participants were requested to report on a regular interval of one week the type of meals (breakfast, lunch or dinner) they consumed, and the number of people who shared their meal. They were also asked to identify the category of food waste that best described their food waste. Additionally, they were encouraged to write down five food items discarded during their meal.

Diaries, when used in the scientific field, travel under several synonyms (i.e. Tagebuch, logbook, self-report sheet, daily event/life report, working journals); take various forms (i.e. structured diary, open ended diaries) and have been used in different circumstances (i.e. travel diaries, cost diaries, health diaries). Diaries used as a source of evidence coincide with reviewing the phenomenon from a day to day perspective and strongly connect daily observations with research actions. A central concern in the studies using diaries is how change occurs and what the processes are behind this change. Self report instruments are proven to be particularly helpful to complement other techniques when the focus of inquiry revolves around understanding the context as well as the phenomenon. Diary exercises are known to provide relevant information on habits and attitudes. In other words, the beneficial attributes of a diary-based examination reside in the fact that moments are captured

as they occur, providing therefore a unique inside view of the household context in which the action takes place.

Table 5-3 Attributes of a diary method approach in the context of a food waste management study.

Attributes	Description
Contextual/ phenomenal layer	Moving outside technical and conventional models of waste data collection. Adding a layer of socio-cultural characteristics to current environmental debates. Useful in providing insight into a phenomenon produced in a real-life setting over a longer period of time.
Detailed account	The contextual patterns of food waste in residential areas at a level of detail that may not be easily attained using modes of inquiries such as kerbside audits.
Understanding the how	Useful when to understand how waste is produced in the domestic sphere.
Low drop-out rate	When administered properly, drop-out rate is low and participants are engaged and provide responses rich in both content and substance.
Increase validity through daily approach	Dairy approaches increase validity when looking at everyday events. A good tool for those interested in day to day life experiences: daily events health issues, everyday practices
Greater meaning	The meaningfulness and reliability of the data obtained from a diary may often be greater than a questionnaire administered on a single occasion.
Low margin of error	Margin for errors decreases as participants are asked to complete a segment at a regular interval.

Source: Adapted from Delongis, 1992

Diaries have clinical roots.[9] Largely limited to research in social science and clinical health studies in the 1960s, more recently diaries have been applied to examine daily waste production. For instance, a diary exercise was undertaken under the auspices

[9] In psychology, diaries are commonly used in the study of mood, stress, personality and behavior. Over the last 50 years, these techniques have evolved into a form of auto-measurement/ evaluation method in the social sciences field. Techniques such as ethnography, personal narratives and reflexivity are rooted historically in the practice of keeping personal diaries and journals.

of the Waste and Resources Action Programme (WRAP) in the United Kingdom[10]. The same idea of food conservation and food waste avoidance was later contextualized to suit New South Wales residents in Australia (Office of Environment and Heritage, 2011).

In this research, an important consideration in the design of the food waste diary is its contextual attribute that attempts to integrate the narratives of locals in contrasting and complex realities. Indeed, the aim was to formulate a set of questions that were applicable, relevant and valid in the specific cultural and geographical household contexts selected for the study. Figure 5-4 illustrates the diary format as it was applied in Mexico. Particular attention was given to the formulation of the questions with regard to the phrasing and the use of common expressions.

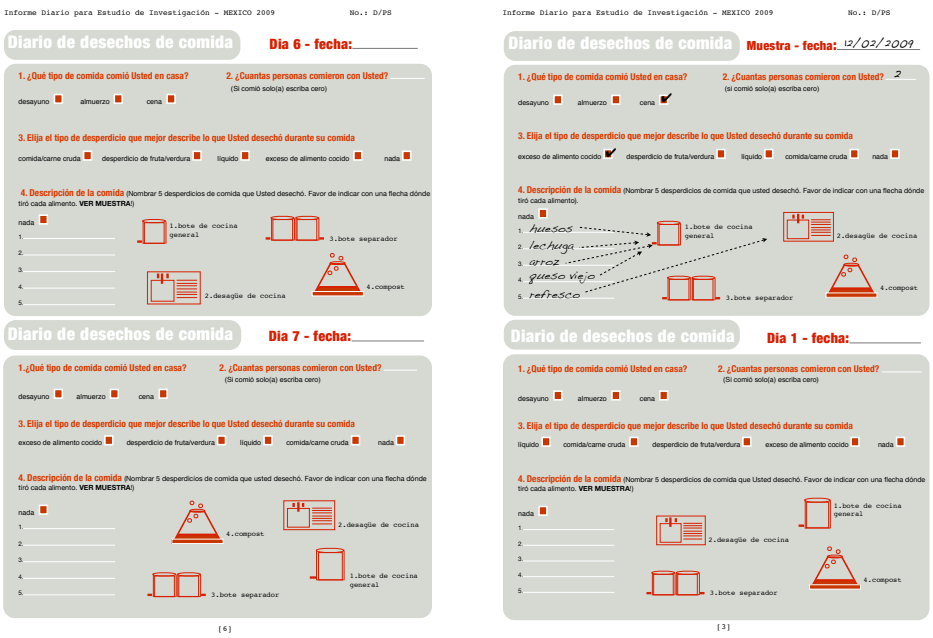

Figure 5-4 Food waste diary format applied in Mexico

[10] The diary developed by WRAP was used to determine the amount of food waste produced in Great Britain. This research was used to raise awareness of food waste produced in residential areas through the 'Love Food Hate Waste' program. See: (Exodus Market Research, 2006; WRAP, 2008, 2011).

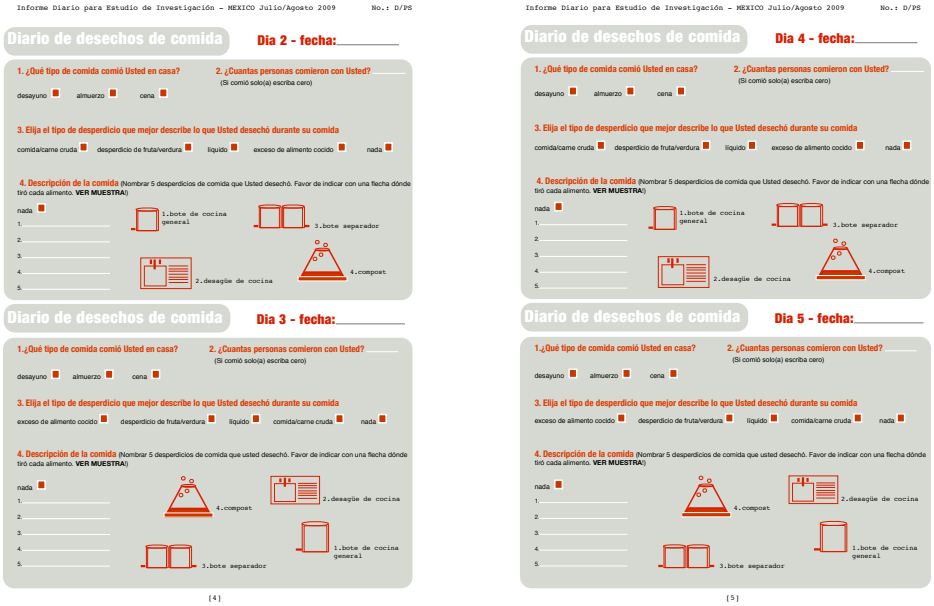

Figure 5-4 Food waste diary format applied in Mexico (cont.)

Because the Diary finds its roots in addressing questions of processes and change, it is inherently a tool that operates gradually, that over time promotes reflection on previous experiences and that adapts to the setting in which it is applied. This brings together theory (i.e. food waste knowledge) and practice (i.e. food waste procedure) based on a household-centered approach. One of the design features is the counterbalancing of the symbols by distributing them into each section as illustrated in question No. 4 of Figure 5-4. This technique helps increase validity by promoting greater awareness and reducing mechanical errors by respondents.

5.3.3 Food waste weighing recording system

The third and final instrument to assess household food waste was a weighing record which was conceptualized to provide a quantitative assessment of the weight and volume of food waste produced in each participating household. Household informants were asked to store the food waste produced in supplied bins and to measure its weight and volume. The weighing period was the same as for the food

waste diary and the procedure was designed to be carried out over seven days. Both weighing recording sheets and bins were provided to household informants who were responsible for weighing their waste and recording on their sheets. The weighing recording sheet was designed to document the waste produced by all household occupants. The frequency of the weighing procedure was optional. Informants could choose to weight their waste daily, twice a week or at the end of the week provided that the bins were not full. The following table shows the specifications of the scale and bins used for the duration of the research.

Table 5-4 Specifications of scales and bins

	Type of weighing instruments	Quantity	Period of use	Location
Scale	Beurer KS58, white 5kg, LCD display, 1g graduation,	2	May 2009-June 2011	Mexico City, Jiutepec
	ONN- E20 digital, Orange 5kg, LCD display Mexico	1	June 2009 - June 2011	Mexico City, Jiutepec
	Salter ARC 1066WHDR08, white 3kg, 1g graduation*	26	23-27 March 2010	Sydney
Bin	Santul 18.0 cm D x 25 cm H, beige	15	June 2009 - June 2011	Mexico City, Jiutepec
	Willows 3506 21.0 cm L x 18.0 cm W X 18.0 cm H white, 1.3 Liter*	26	23-27 March 2010	Sydney

* The results of the application of the weighing exercises in Sydney are not included in this dissertation as focus is given to the Latin American context. For more details on the results of the study conducted in Sydney see: (Jean-Baptiste, et al., 2011).

It is important to stress that waste weighing approaches are based on traditional methods of waste estimation, which are generally calculated in tones which is the most common measure of waste weight. The calculation of waste by weight has been used as a means to estimate tipping fees in waste depositories, landfill and more

recently in the recycling industry. Bin-weighing systems have been introduced to enable waste practitioners to make waste collection and recycling more efficient.

The weighing procedure designed for the research used a kitchen scale to measure the amount of waste produced daily or every two days depending on the number of household occupants. Informants were responsible for recording the weight of food waste produced in their home for a week. The food waste was weighed on different types of electronic kitchen scales with a capacity of 3kg to 5 kg.

The scales and bins mentioned above were selected based on a number of assumptions and previous estimations of the average waste production per person in urban areas as recorded in the literature. It was estimated that the maximum waste production per capita would range between 1.3 kg to 1.5 kg per day. From this calculation an appropriate kitchen scale was selected.

Figure 5-5 Beurer scale used for weighing recording tests

Medición Estudio México - 2009 No.SST/

Medición habitacional Encuestador_____

Login participante

Genero

Masculino Femenino

Grupo de edad al que Usted pertenece?

18-24 45-54 35-44

25-34 55-64 arriba de 65

¿Cual es su actividad diaria?

Estudiante

Trabajo media jornada/tiempo completo

Desempleado

Administradora de casa/cuidando hijos

Jubilado

Test #1 - Fecha_____	Test #2 - Fecha_____	Test #3 - Fecha_____
1. tipo de bote suministrado privado	1. tipo de bote suministrado privado	1. tipo de bote suministrado privado
2. Volumen 1/4 1/2 3/4 lleno	2. Volumen 1/4 1/2 3/4 lleno	2. Volumen 1/4 1/2 3/4 lleno
3. Peso bote vacio _____ kg/ lb	3. Peso bote vacio _____ kg/ lb	3. Peso bote vacio _____ kg/ lb
4. Peso bote lleno _____ kg/ lb	4. Peso bote lleno _____ kg/ lb	4. Peso bote lleno _____ kg/ lb
Observaciones	Observaciones	Observaciones

[1]

Figure 5-6 Food waste weighing recording sheet used for weekly estimations

5.4 Knowledge base from pilot studies

As previously mentioned, the research design incorporated the refinement of each tool over time. Each improvement allowed changes and modifications to fit into the geographical context where the tool was applied. Overall, there was a strong belief that conducting research 'with others' and 'for others' would yield results that are of a richer nature than without those connections. For that reason and when possible, communication with participants was stretched over time allowing more opportunities for exchange and collective reflection. The field studies offered an opportunity to test the relevance of participatory research techniques and to explore questions of social engagement and the nature of relationships between individuals and local waste practitioners and authorities that operate among them. During the

field studies the most important lessons learned related to:

(1) Building alliance and trust

(2) The role of informants

(3) Spiral process

(4) Nuclear knowledge

Building alliance and trust

In regard to the role of participants, the data collection was dependent on their willingness to share their daily routine, to examine closely the type of food waste they produce and their interest in reflecting on their waste habits. The results of the composition of food waste in Chapter 6 are based on an insider outsider complicity scheme which required recruiting participants among acquaintances or through nodes of networks. In Mexico, there was a certain level of perceived intrusion of the household in order to conduct food waste weighing procedures. This implied a level of trust that often exceeded traditional researcher-participant relations.

The role of informants

Each household was represented by an informant who was considered as an associate rather than a subject of the study.[11] Each informant played a central role in the data collection and his or her involvement was considered from an early stage of the research design. Household informants varied from 18 to 64 years of age. They were responsible for reporting the food waste habits in their household and served as links between household occupants and the researcher. Text messages and/or emails were sent to informants as reminders while filling in the diary. It is important to stress that informants had a greater level of engagement and a certain degree of autonomy in terms of the frequency with which they would for instance weigh the food waste produced in their households. Their role was also central to disseminating the idea of food waste production and management in the household. As is often the case in Action Research related studies, the researcher played the role of facilitator, taking a step back to allow participants to take on a more active role in the research (Greenwood & Levin, 2007).

Continued spiral process

Measuring food waste disposal practices not only required a strong participatory component but also some flexibility in the application of the procedures and the capacity for adjustments as the research progressed. This continued spiral process which alternated between action and adjustments of tools, implied and resulted in a continued refinement of the method. The research implementation included an imprecise start that was improved and took shape over time as the particularities of food waste management and the urban context became more coherent. During the field studies, planning activities included for instance, informant recruitment and tool procurement. These tasks proved to be highly important as they ensured

[11] Each informant acted as the main contact person and the data collection task force, responsible for reporting on how food waste was produced in residential units. Each household inquiry was conducted through an informant. This person was given a short explanation about the purpose of the research and of his/her possible role. The informant filled in the questionnaire, completed the diary and also conducted the weighing record procedure.

continuity and coherency in the data collected. In Mexico for instance, each household unit identified had a different dynamic and each informant provided a unique view of the problem posed to them. Acting as a facilitator and reflecting on the participative-oriented components of the tools, shaped the research empirical framework. Few results were rejected as each contribution was considered as valid and supported by the value of local knowledge and narrative.

Nuclear knowledge

The methodological strategy used an investigative framework that required a longer period of time than many other methods as well as significant financial resources to collect the necessary data. This type of research design is not suitable for statistical purposes as the data obtained is case-specific and cannot reflect generalization to an entire population. Rather, the method aimed at understanding the multiple realities that exist in a specific context and examined the interdependence factors of food waste management. It is a strategy of inquiry in which the 'context' and the 'human instrument' are heavily implicated in the analysis.

The methodological strategy is concerned with behaviors or circumstances in real life situations based on a *verstehen* principle. This implies an intensive and close contact with participants with the aim of developing a number of tentative explanations about the why and how of food waste production in residential areas. This strategy is inherently nuclear and focuses on the depth rather than on the breadth of information. The experience in the field and the learning process obtained during pilot tests showed that such types of inquiries are difficult to manage with a large sample. The lessons learned in the field showed that a set of 20 cases is sufficient to extract multiple circumstances of food waste habits and a larger sample becomes difficult to operationalize without the support of third parties.