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Of practices and (micro)politics: Challenges of organic waste segregation in Dschang, Cameroon

Authors:

Eric MOYE KONGNSO, University of Dschang, Cameroon. moyeeric@yahoo.com

Aristide YEMMAFOUO, University of Dschang, Cameroon. aristide.yemmafouo@univ-dschang.org

Joël SAGNE MOUMBE, University of Douala, Cameroon. jojojoel7@gmail.com.

Rolande Christelle MAKAMTÉ KAKEU–TARDY, Institute of Geography and Sustainability, University of Lausanne, Switzerland. rolandechristelle.tardy@unil.ch

Marlyne SAHAKIAN, Department of Sociology, University of Geneva, Switzerland. Marlyne.Sahakian@unige.ch

René VÉRON, Institute of Geography and Sustainability, University of Lausanne, Switzerland. rene.veron@unil.ch

Abstract

Waste generation in Sub-Saharan Africa is increasing rapidly. While biodegradable waste remains predominant, it is rarely treated separately by municipal solid waste management systems, thus foregoing the possibility to reduce the volume going to landfills or dumpsites. This paper discusses the unique case of the small city of Dschang, Cameroon, where the municipality operates two central composting plants that treat about 20% of the city's household and restaurant waste. Using Urban Political Ecology and Social Practice Theory, this article studies waste flows, waste practices, material arrangements, power relations, social norms, institutional dynamics and policies to identify opportunities and obstacles for organic waste sorting at the level of households and restaurants. Our analysis draws upon qualitative and quantitative data and points to the importance of the availability of multiple waste bins and monetary compensation for organic waste sorting. These factors have also facilitated the development of an informal waste sector, which might use up to 20% of the city's waste as animal feed and for home/farm composting. However, complex relations between multiple actors and the national policy framework complicates the emergence of organic waste segregation at source as a common practice. In this way, the study shows that solid waste management is also a matter of power and (micro)politics.

Keywords: *Waste Segregation, Everyday Practices, Power Relations, Cameroon*

1 Introduction

Increasing waste production in Sub-Saharan Africa results from the conjunction of rapid population growth, urbanization and changing lifestyles (Mbue et al., 2015). The proportion of the urban population is expected to rise from 36.3% in 2010 to 56.5% in 2050 (UN 2012, p. 3) while the waste production rate of 0.74 kg per capita per day is expected to triple within the same period (Kaza et al., 2018, p. 3). At the same time, waste composition is changing: more plastics and other packaging materials end up in the municipal waste stream (Achankeng, 2004). Therefore, mixed municipal waste is increasingly piling up in landfills and being dumped, leading to both environmental and health problems (Malika et al., 2015).

The dominant waste type produced in Sub-Saharan Africa remains organic; food and green waste accounts for 56% (Kaza et al., 2018, p.8) – in Cameroon, almost 50% (Mbue et al., 2015, p. 95) – of municipal waste. Yet, there are regional variations (Mbiba 2014, p. 4). Recycling has been identified as the main factor influencing solid waste segregation at source in developing countries (Asong, 2010; Sin-Yee and Sheau-Ting, 2016). However, municipal solid waste management systems in Sub-Saharan Africa (including Cameroon) rarely involve separate treatment of organic waste, such as composting, despite its proven agronomic, economic, health, and environmental benefits (Bodegom et al., 2019; Kabasiita et al., 2021; Sagneet et al., 2020).

A well-known key challenge worldwide for composting from kitchen waste is to bring waste segregation as close as possible to the source of waste generation (Mu'azu et al., 2018; Viljoen et al., 2021). In the global North, various factors have facilitated waste segregation at source (Trushna et al., 2024), including awareness-raising and environmental consciousness (Srivastava, 2016; Ernstson et al., 2021), enforced laws and regulations (Manzi, 2015; Di Maria et al., 2017), economic incentives (Friege, 2018), infrastructure in terms of collection and distance to bins (DiGiacomo et al., 2018). By contrast, the literature on the global South is relatively scarce (Trushna et al., 2024) and points to various constraining factors, including lack of awareness (Malika et al., 2015; Pandet et al., 2019), insufficient economic incentives (Sin-Yee and Sheau-Ting, 2016; Santos, 2017 and Pandet et al., 2019), absence of a legal framework or of its enforcement (Manga et al., 2007; Manga et al., 2019), lack of political will (Teshome, 2021), poor technologies and knowledge systems (Achankeng, 2004), as well as unfavorable behaviors, social norms and cultural features (Aktas et al., 2018; Corsini et al., 2019). However, willingness of households to participate in waste separation has also been reported (Mbiba, 2014) and multilayered, power-laden sorting and recycling practices exist in Sub-Saharan Africa beyond the formal waste management system (Sseviiri et al., 2022). Yet, social and power relations, as well as (micro-) politics, underlying waste segregation practices are rarely captured in the literature.

This study attempts to fill this gap in knowledge by examining opportunities and obstacles for waste sorting (at source) based on an analysis of existing waste flows and practices, as well as related power relations in the provincial city of Dschang, Cameroon. We address the following research questions: (i) what are the current waste practices and waste flows in Dschang (urban metabolism in relation to waste)? (ii) What everyday practices related to waste sorting can (not)

emerge given infrastructural conditions, existing skills, and social norms? (iii) what are the obstacles and power relations that influence the waste flows and practices, in particular waste segregation?

We chose Dschang for this study as an exemplary or “extreme case” (Seawright and Gerring, 2008). It represents a rare case of a small or medium-sized city in Sub-Saharan Africa with a formal organic waste management system: two municipal composting facilities have been set up here under an international development project. The local institutional context for waste segregation at source is also favorable with a waste-specific municipal agency interested in its promotion. Other factors of Dschang’s context are less unique, such as the availability of biodegradable waste for composting (typical for humid zones in Africa) or the widespread use of kitchen waste for animal feed (a common practice that is, however, rarely examined in the literature).

After this introduction, we present the theoretical framework of the study combining Urban Political Ecology (UPE) and Social Practice Theory (SPT) that allowed us to frame the above research questions and to generally guide the analysis. In Section 3, the methodology is introduced followed by empirical data analysis in Section 4, which involves a description of the urban metabolism of organic waste and its key actors in Dschang (4.1), the identification of material, social and economic factors that constrain and facilitate waste segregation at the level of households and restaurants (4.2), a presentation of the economic and political challenges of centralized composting in the absence of segregation at source (4.3), and an analysis of the constraining political and institutional framework in Cameroun (4.4). In Section 5, the findings are discussed in the framework of UPE and SPT leading to the formulation of policy recommendations.

2 Theoretical Framework

Waste segregation needs to be seen in the wider context of the urban metabolism, the flows of matter and energy in and through cities. In the African context, an understanding of the urban metabolism of organic waste also needs to consider urban agriculture and animal husbandry. Particularly in combination with compost-based urban agriculture or the rearing of animals fed by kitchen waste, the sorting of waste influences the urban socio-ecological regime by changing what is taken from, as well as returned to, nature (Haberl et al., 2016). Such an urban metabolism is associated with the concept of a circular economy (Bahers and Giacchè, 2018) and the idea of reducing materials flowing in and out of cities (Barles, 2014). Households have a role to play in such a process: waste segregation, compost-based urban agriculture and local animal husbandry can thus also reduce the metabolic divide between town and countryside.

Urban Political Ecology (UPE) allows for the examination of Dschang’s urban metabolism related to biodegradable waste with an emphasis on actors, power relations and uneven urban spaces. UPE posits that changes in metabolic processes are linked to the practices of urban actors embedded in the larger political economy (Heynen et al., 2006). For instance, industrialization, as well as the

emergence of industrial agriculture and consumer society, led to a metabolic rift and an environmental crisis that is experienced differently across space. UPE seeks to uncover the power relations, institutions, and discourses that, together with biophysical dynamics and built infrastructure, coproduce uneven urban space (Heynen et al. 2006), including differentiated access to waste services in cities or disproportional exposure to waste hazards (Véron et al., 2018).

Apart from larger-scale parameters, such as legal frameworks (Njeru, 2006) or processed food imports (Legwegoh and Hovorka, 2013), the urban metabolism of organic waste is influenced by social relations at the local level, such as power relations between municipal governments and citizens, waste generators and waste workers or gender relations within households, necessitating situated analysis (Lawhon et al., 2014). Applied to municipal waste management, Situated Urban Political Ecology (SUPE) has pointed to micro politics in small-town India, for example, that shape opportunities and obstacles of segregation at source (Cornea et al., 2017b). Going back a step further, other studies have shown the importance of varied waste ontologies between actors: while some (e.g., waste pickers) see waste as a resource, others (e.g., waste managers) see it as a hazard (Moore, 2009).

While SUPE emphasizes the importance of everyday practices leading to incremental socio-ecological change (Lawhon et al., 2014; Cornea et al., 2017a), it largely fails to theorize human actions and practices. To fill this gap, we draw on Social Practice Theory (SPT), which has become prominent in sustainable consumption studies (cf. Sahakian and Wilhite, 2014; Strengers et al., 2015). SPT examines practices through three interrelated dimensions: material arrangements and technologies; knowledge, competencies and skills; and social norms and meanings (Shove and Spurling, 2013; Spurling et al., 2013; Keegan and Breadsell, 2021). Rather than concentrating on individual behaviors, attitudes and awareness, SPT focuses on how social practices evolve through the interplay of material arrangements, skills and norms, and how they ‘recruit’ new members over time (Dubuisson-Quellier and Plessz, 2013). SPT is useful for the analysis of opportunities and constraints for the spread of everyday waste segregation by pointing to the importance of material arrangements (e.g., availability of bins for storing kitchen waste and space), skills (e.g., knowledge to segregate properly and to make good-quality compost) and social norms (e.g., stigmas around touching garbage) (Aktas et al., 2018; Corsini et al., 2019).

3 Methodology

3.1 The Study Area

Located in the West Region of Cameroon, the small city of Dschang is the headquarters of the Menoua Division (see Figure 1). It has a surface area of about 5,655 hectares (POS, 2010, p. 10), a population of about 150,000 inhabitants and an average density of about 300 persons/km². Dschang can be considered a third-tier city in Cameroon’s urban hierarchy and has an average growth rate (3,2%), but an important student population of about 30,000 persons (POS, 2010, p. 24). The biophysical environment is conducive for urban and peri-urban agriculture; road

accessibility to the national metropolises of Douala and Yaoundé also facilitates the marketing of local agricultural products.

In the context of Cameroon's decentralization policies, the municipality manages local affairs, including waste management and sanitation. Solid waste management of medium-sized cities in Cameroon, as well as some small cities, has been entrusted to a national private company (Hysacam) since the mid-2000s, but Dschang Municipality continues to be directly involved in household waste management. Until 2015, municipal waste management was limited to the collection of waste in the more central parts of the city and its disposal in the landfill. However, since the implementation of an international development project funded (in part through carbon credits) by the European Union, the City of Nantes in France and other partners, the waste management system has improved gradually since 2015. For example, a special purpose organization, the Municipal Agency for Waste Management (*Agence municipale de la gestion des déchets*, AMGED) was established and two municipal composting facilities (locally referred to as "platforms") were created. In addition to municipal waste collection, furthermore, public-private partnerships have developed at the local level for waste collection in less accessible, more peripheral parts of Dschang. This collection, locally referred to as "pre-collection", has influenced waste practices at the household level (see Section 4.3.2).

3.2 Research Design and Fieldwork

This study draws upon quantitative and qualitative data collected mostly through a household survey, as well as semi-structured interviews with restaurant managers and key informants.

A survey with 265 households was conducted to gain a picture of household-level food consumption, waste generation, waste practices, composting, know-how, infrastructure and waste-related tensions, as well as on collection services. The respondents were selected by semi-purposive sampling. First, six neighborhoods were chosen based on their socio-demographic characteristics, accessibility and relation to Dschang's waste system. Asseintsa represents a central, planned, middle-income neighborhood served by municipal waste collection; Haoussa is a relatively dense, underserved Muslim quarter close to municipal waste dumps; Fiankop II forms a low-income neighborhood partly connected to municipal collection; Vallée is a student area with hostels near the university campus; Mingou is a relatively inaccessible, informal settlement; and Tsingkop represents a peri-urban area where many households practice farming. Second, the settlements were mapped and delimited using cartographic tools and 50 buildings per neighborhood were selected randomly. One randomly selected person from each selected building was interviewed with their explicit consent. In 35 buildings, nobody was living, available or willing to participate in the research despite our frequent revisits. Forty-seven percent of our respondents were women.

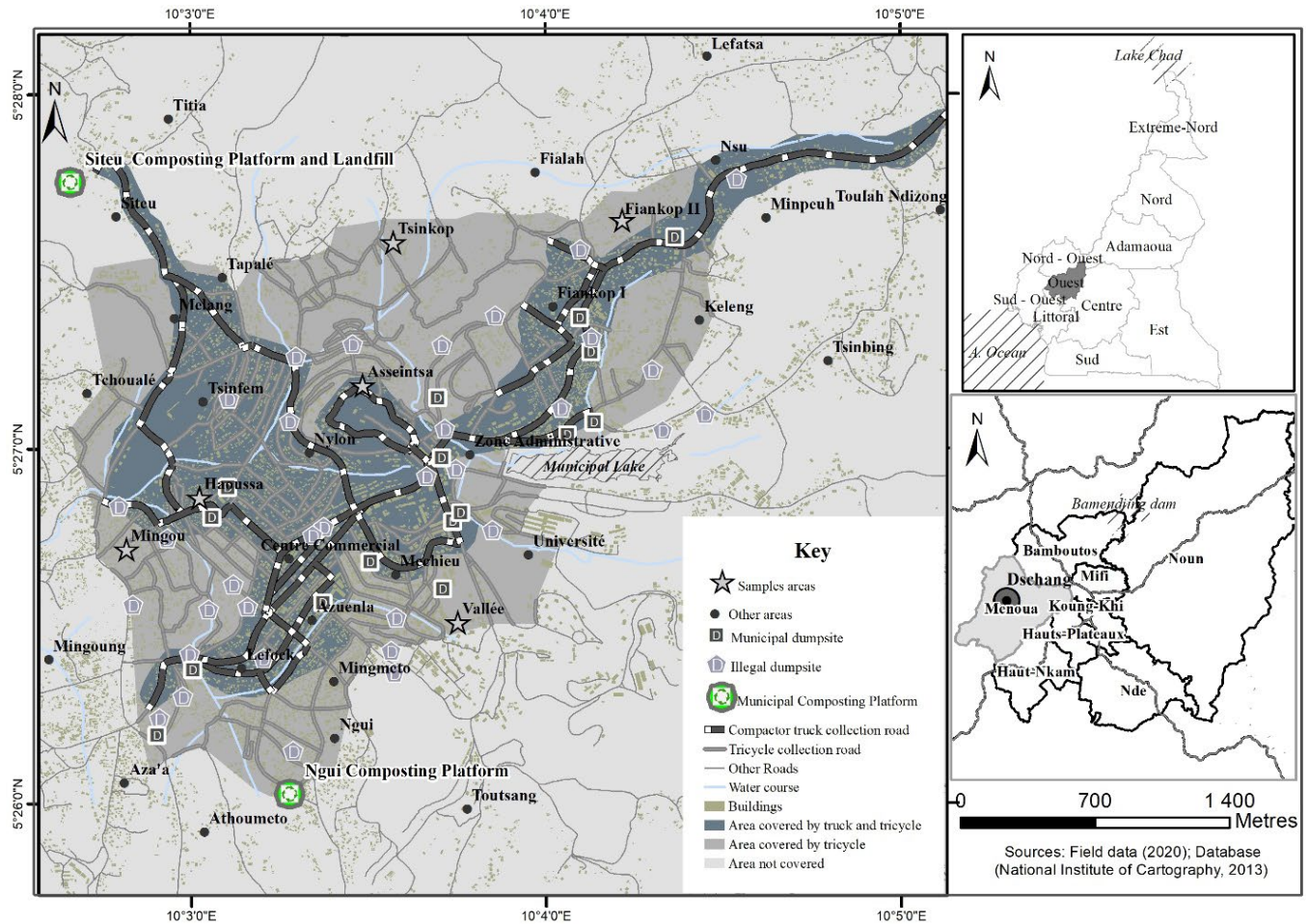


Figure 1: Map of study sites and waste infrastructures in Dschang

The household survey was carried out in September 2020, after the COVID-19 lockdown, with the help of five experienced enumerators. The questionnaire contained 79 closed and open-ended questions and took about 30 minutes to complete. Data was entered directly on smartphones with the help of KoboCollect and then transferred to spreadsheets for analysis.

Furthermore, we conducted six semi-structured interviews with restaurants, the other main organic waste generator in Dschang and key source of the city's informal organic waste management. Interviews were conducted in August 2020 with two establishments of "high standing" (in terms of price, modern infrastructure, food preparation on the premises, central location, etc.), two mid-range eateries (in terms of price, service, and location near the market and government offices, etc.) and two food hawkers (low prices, food prepared at home and brought there, no waste bins, etc.). These interviews lasted about 30-40 minutes and addressed kitchen waste generation, segregation practices and the relationship with buyers of biodegradable waste.

We also conducted twelve key informant interviews, four with local delegates of central ministries that are closely related to solid waste management (housing and town planning, land tenure, environment, and agriculture), two with municipal authorities (a representative of AMGED and an operator of a composting platform), three with the private pre-collection associations, and three with urban farmers producing and using compost. The in-depth key informant interviews lasting between 35 and 60 minutes were used to gather additional information on issues such as constraints and opportunities for composting and compost-based farming, the applicability of regulations in the domain of waste management and urban farming, and power/social relations between stakeholders in the waste management sector in Dschang and beyond.

Interview data were analyzed using quantitative and qualitative techniques. Questionnaires were coded and descriptive statistics were produced using Excel and SPSS. Semi-structured and key-informant interviews were conducted in either French or English, recorded and transcribed. Transcripts in French were later translated into English and then analyzed using thematic and content analysis with the aid of Atlas.ti software.

Furthermore, interview data were complemented with field observations of the state of infrastructures, techniques and practices in households and on farms, restaurants and at the composting platforms, as well as with existing documents (for example annual reports of AMGED). This combination of information also allowed us to identify the major material flows related to biodegradable kitchen waste in Dschang and estimate their relative importance. Moreover, we collaborated with soil scientists who tested soils and composts. We used the laboratory analyses to assess compost qualities (influenced by household practices such as sorting) because they form a relevant part of the material arrangements of an organic waste management system.

4. RESULTS

4.1 Urban metabolism of organic waste in Dschang

Figure 2 depicts the major municipal solid waste flows in Dschang. Annual municipal waste generation in Dschang is estimated to amount to about 25,000 tons (or about 0.65 kg per capita per day). More than 83% of waste is biodegradable (AMGED, 2015, p. 11). While the per capita generation of waste is near the average for sub-Saharan Africa, the proportion of biodegradables is high (see above). In sum, almost 21,000 tons of organic waste per year is theoretically available for composting in Dschang.

About half of the garbage enters the formal waste management system. (This is close to the estimated average collection rate of 44% in sub-Saharan Africa (Kaza et al. 2018, p. 4). The municipality collects 10,000 tons of mixed waste a year (40% of total municipal waste) transporting it to the waste facility in Siteu by (compactor) trucks (see Figure 1). Almost $\frac{3}{4}$ of this waste, including the decomposing litter from along the main roads, is put directly in the landfill;

the other $\frac{1}{4}$ is treated at the municipal composting platform in Siteu. Furthermore, three assigned private associations gather 2,300 tons mixed waste per year (9%) by tricycle from less accessible areas. They bring all the collected waste to the Ngui composting platform (see Figure 1). In the current absence of selective waste collection, waste workers at the two composting platforms must sort the mixed waste (about 5,000 tons annually, or 20% of the total municipal waste). About 1,000 tons every year (4%) of segregated non-biodegradable and semi-decomposed waste goes from the platforms to the landfill. Another 1,500 tons annually (6%) is sieved out: half of it goes to the landfill and the other half is used as backfill. After water reduction, 550 tons of compost is produced annually in the end from about 10% of Dschang's total garbage, while 36% end up on the landfill (AMGED 2020) (see Figure 2).

Outside the formal system, 29% of the households practice waste segregation at source, according to our survey. Segregated kitchen and restaurant waste, roughly 20% of Dschang's municipal waste, is used or sold as animal fodder (in four out of five cases) or as raw material for composting (in one of five cases). The non-utilizable organic and the non-biodegradable waste from this segment enters the formal or the unmanaged waste stream. A negligible amount of biodegradable waste is treated in community composting bins established by AMGED as an educational tool for urban farmers.

The remaining 31% of Dschang's municipal waste is not managed and ends up in the open environment (Figure 3). Illegal waste disposal occurs primarily in areas that are difficult to access with vehicles and that are not served by formal collection. From these dumps, waste pickers extract some recyclable materials, such as glass or metals, but not organic waste.

Apart from material flows, Figure 2 shows the spaces where waste sorting is taking place in Dschang; that is, in homes and restaurants, as well as at the municipal composting facility and, to a lesser degree, on illegal dumps. The waste flows also point to some actors that are directly and indirectly involved in waste segregation, such as household members, restaurants, breeders and farmers in the case of the informal system, or the municipality, private associations, waste collectors and workers at the platforms in the case of the formal system. In line with UPE, the following subsections examine the practices and power relations of these actors that shape Dschang's urban metabolism.

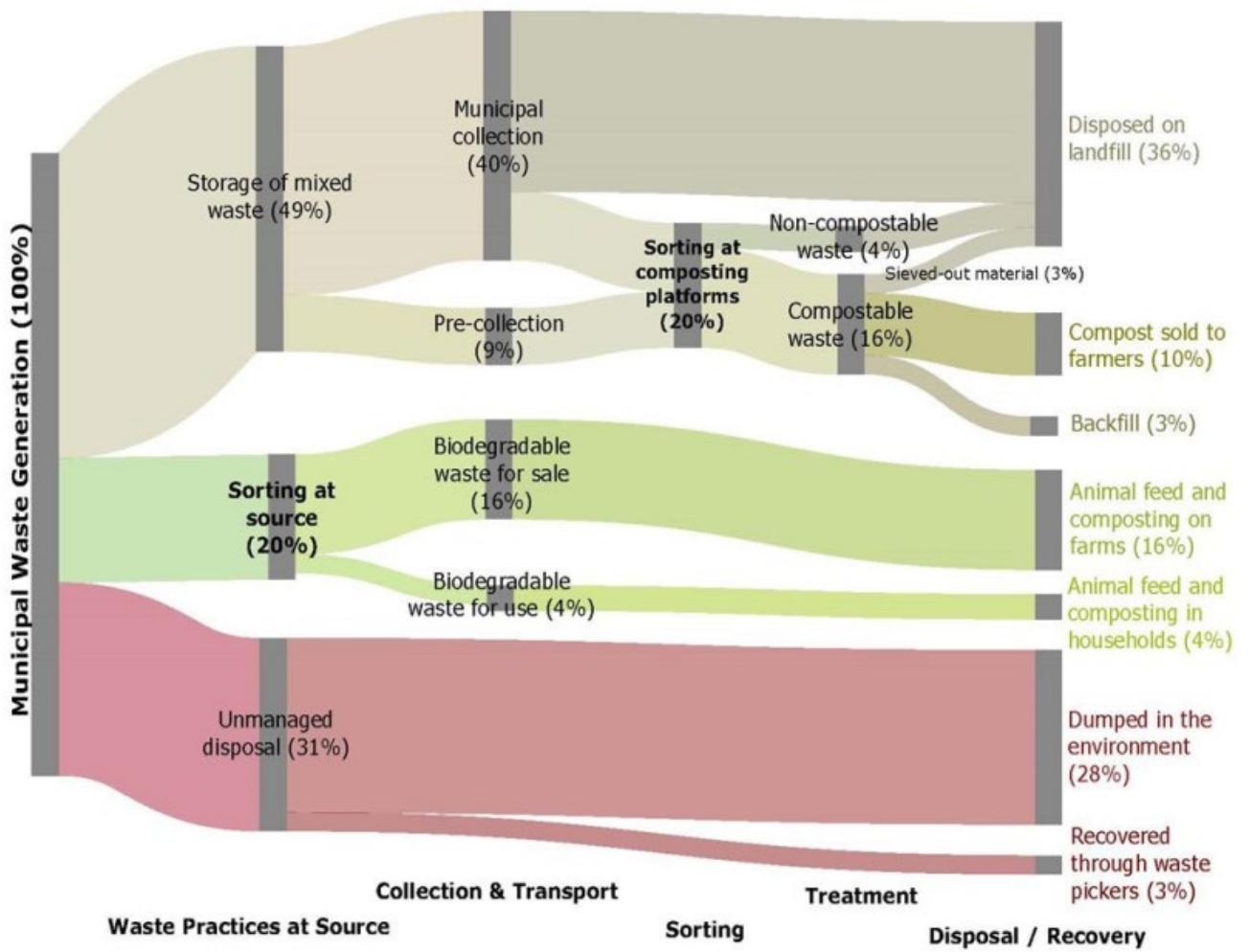


Figure 2: Estimated organic solid waste flows in Dschang (Source: AMGED, 2015; fieldwork, 2020). The graph does not represent the changing mass of the waste (products), particularly through loss of water.



Figure 3: Illegal waste disposal practices in Dschang

4.2 Waste segregation at source

4.2.1 Obstacles: lack of incentives and infrastructure

According to our household survey, only a minority of households in Dschang (29%) practice waste segregation at source.

A first obstacle is the absence of material arrangements conducive for waste sorting, including the deficiency of waste receptacles and storage space at the household level and the lack of a formal separate waste collection system for biodegradable and non-biodegradable garbage. Fifty-six percent of our respondents reported that the lack of appropriate dustbins prevents them from sorting their waste. Waste receptacles used in Dschang include nylon bags (44%), plastic buckets (43%), and baskets (13%) (see Figure 4). The lack of multiple bins and the poor quality and state of receptacles, commonly observed in lower-income households, hinders waste segregation and limits the time that waste can be stored. Waste in these households must be disposed of soon after it is generated. In most cases, nylon bags used as waste receptacles are thrown out together with the (organic) waste, which renders waste segregation futile. Furthermore, small kitchen spaces hinder waste segregation at source: 94% of households put their dustbins outside their (small) kitchen because of the bad smells rendering waste segregation impractical.



Figure 4: Types of dustbins used in households and restaurants

Second, no social norms or intrinsic environmental or cultural values are associated with waste segregation in Dschang. Qualitative responses of the survey showed that households generally see the sorting out of biodegradables as a waste of time to which no positive meanings are attached, except a potential source of income or savings (see section 4.2.2). Given the inconvenient material arrangements at the household and municipal level, waste segregation appears tedious, time-consuming and even pointless. Economic compensation for the time used for sorting waste is therefore expected.

These findings largely confirm those from the literature: The lack of (economic) incentives, social meanings attached to sorting and conducive material arrangements discourage waste segregation at source (Sin-Yee and Sheau-Ting, 2016). However, the reasons for the absence of incentives and infrastructure require further (political) analysis (see section 4.4). Skills are less of an obstacle than suggested in the literature (Achankeng, 2004). Our field observations show that the distinction between biodegradable and non-biodegradable waste is generally known to people in Dschang due to their proximity to agriculture.

4.2.2 Existing waste segregation at source: informal markets and social relations

Despite the above-mentioned obstacles, 29% of the households in Dschang sort biodegradable waste at source. However, this existing form of waste segregation is mostly utilitarian and does not follow the standard ‘scientific’ waste categories; not all biodegradable waste is sorted but only the organic substances that can be used, gifted, or sold. In fact, sorting organic waste at source is closely related to other practices, such as animal husbandry and crop farming, which are widespread in the “agricultural city” of Dschang and its surroundings (Legwegoh and Riley, 2022). Thirty-six percent of the surveyed households reported agriculture as their main source of livelihood; another 52% of the households engage in agriculture as a subsidiary activity. Vegetables and corn are cultivated on small homesteads for own consumption; a wider variety of crops are grown on larger plots, including for sale. Almost half of the households raise livestock, mostly poultry (Legwegoh and Riley, 2022).

In terms of waste management, pig farming is of particular importance. Eighty-two percent of the households who segregate waste at source (or 24% of all households) are motivated by using or giving away kitchen waste as animal fodder. They put aside leftover food, as well as vegetable stems and peels from plantains, bananas, potatoes, etc., to feed pigs and, to a lesser extent, chickens. Sixteen percent of the households raise pigs – a practice that has a long tradition in Dschang and has been on the rise as a secondary economic activity, particularly in the urban periphery. It is predominately practiced in low-income, large, polygamous households, where children segregate waste and look after the pigs. It is inhibited by social norms only among the Hausa (Muslim) minority community.

Another 18% of households involved in waste segregation at source (or 5% of all households) use biodegradable waste for compost-based farming, a practice for which skills are widespread in the “agricultural city” of Dschang. Material arrangements for waste segregation in a farming household appear simple, as an urban farmer indicated: “We have a bag into which we put the organic waste and another one for inorganic waste. The bag for organic waste is the one we bring to the farm” (Interview, 20/06/2020). Some urban farmers have also developed the skills to produce organic fertilizers by mixing animal droppings with kitchen and green waste. This fertilizer, locally referred to as “agrocompost”, seems particularly beneficial for application on the generally phosphorus-poor soils in Dschang: our laboratory analyses found 3.4 g of bioavailable phosphorus per kg in the “agrocompost” while other composts in Dschang contained less than 1 g per kg (Fischer, pp. 57-58).

Interestingly, the reuse of biodegradable waste is not limited to the household level or to the urban periphery. Indeed, an informal economy for directly usable biodegradable waste has evolved in Dschang. Several medium- and upper-scale restaurants have entered into agreements with larger-scale pork farmers (with more than 10 pigs) and waste pickers. A restaurant owner in Central town, explains that waste pickers provide containers into which usable organic waste is put during the day. In the evening, the waste pickers collect the reusable kitchen refuse and then sell it to pig farmers. When the waste picker does not show up, however, waste segregation stops, as this restaurant owner described in her own words: “I do not separate waste every day, I do it when he [the waste picker] brings a bucket for it” (Interview, 10/07/2020). In other cases, restaurant owners, including small hawkers, let informal waste pickers go through their garbage and sort out useable kitchen waste. Both households and restaurants also give their sorted waste to friends and family members without expecting any payment. A female eatery owner, for example, stated: “I segregate waste for my brother who rears pigs. He brought a bucket into which I put organic waste, and he collects it every evening. This is the reason I sort waste and I can stop only if he stops coming” (Interview 18/07/2020). Furthermore, crop farmers encourage their neighbors to put organic waste in bags they hang near their fields. An urban farmer goes farther: He provides waste bags to households in his neighborhood and asked them to provide him with their kitchen waste in return for compost and seedlings (Interview, 13/08/2020).

These examples show how material arrangements (the provision of receptacles) and economic incentives (the sale of kitchen waste and saved waste pre-collection costs) can overcome obstacles to waste segregation at source. By pointing to the role of infrastructure and incentives, our findings generally confirm the existing literature (Sin-Yee and Sheau-Ting, 2016; Pandet et al., 2019). However, they also underline the importance of norms, which are discussed in the literature mainly as individual attributes (e.g., environmental awareness) rather than as social relationships, exchanges and moral obligations. Yet, social relations have proven almost as important for the segregation and reuse of kitchen waste as economic incentives, particularly in the case of composting that is less monetized than animal fodder.

While this informal form of waste segregation at source contributes to a localized circular economy, it also reproduces power relations between members of the family and gender roles enshrined in social norms. One of our respondents reported: “women and children are responsible for waste management. Waste is produced during cooking. Women, who are in charge of cooking, also have the responsibility to manage waste” (Interview 10/07/2020). Other research participants explained that men would be tagged as weak and controlled by their wife if they took waste to the roadside when their wife and children are at home. Our survey shows that children manage waste in 64% of the households. When there are no children, it is mostly women who take care of the waste (26% of the households). Waste segregation at source contributes to the work burden of women and girls, in particular. In large households (with six or more persons), for instance, parents instruct their children to sort waste and feed animals after school and on Saturdays. In these cases, there is a division of tasks between boys and girls. Our survey shows that in households with both girls and boys, it is always the girls who are asked to handle and sort kitchen waste. However, it is the boys who get involved and benefit when it comes to sorting waste for sellable recyclables or reusables. Recently, women and girls have started contesting these culturally enshrined roles which has led to gender conflicts that may influence future waste practices.

4.3 Formal waste management and segregation

Whatever opportunities and threats the informal practices of waste segregation at source contain, the international project has not been built on this existing practice when devising the new organic waste management system in Dschang in 2015. The municipal agency AMGED did not introduce separate waste collection of biodegradable and non-biodegradable waste. Therefore, the collected mixed garbage needs to be manually sorted at the two composting facilities. However, this implies a number of challenges.

4.3.1 Challenges of centralized waste segregation: production costs, gendered labor conflicts, quality issues and NIMBYism

For instance, the representative of AMGED is displeased with the centralized system because “waste sorting at the composting platforms is the most expensive and time-consuming operation” (Interview, 2/09/2020). It represents 50% of the labor input and cost at the composting facilities and adversely affects the economic viability of the project. In fact, the income from the sale of compost covers only 48% of the relatively high production cost. Dschang’s municipal waste management project therefore continues to be dependent on co-financing from international cooperation.

Furthermore, waste sorting at the municipal facilities has given rise to gender conflicts. The painstaking work of sorting is mostly done by female laborers using tables under the recently installed roof, which provides them protection from the sun and rain, while the male workers take care of turning the compost and packaging it. The manager of one of the platforms told us that he assigns the sorting work to women as they would be “more stable and efficient” than male workers (Interview, 02/07/2020) thus reinforcing gender stereotypes. However, when female laborers started to put aside and sell recyclable materials, the men protested. Eventually, a profit-sharing mechanism has been put into place so that all the workers at the platform now benefit from sorting and selling recyclables, which represents an important complementary source of income for the waste workers given their low salaries.

The quality of the raw material (organic waste) represents another challenge for AMGED. Not all organic waste can be used for composting at the municipal platforms; the sorters must put aside waste that arrives already half-decomposed. Despite daily collection, some households store their mixed waste for more than 72 hours after which it can no longer be used for composting; the occurring fermentation and contamination with heavy metals would produce low quality compost (AMGED 2020). In the past, female waste sorters removed higher-value organic waste, such as fresh banana peels or vegetable stems, to feed it to their own pigs. This practice was banned in order to maintain the quality and quantity of raw material available for composting.

Furthermore, organic waste is more likely to get contaminated from non-organic matter on the municipal compactor trucks used by AMGED than on tricycles used in “pre-collection”. Our laboratory analyses indeed show higher contamination with chromium of the municipal compost in Siteu than in Ngui, for example. Furthermore, the C/N ratio of the compost in Siteu is high (27), indicating an insufficiently matured compost – its application may consume nitrogen rather than provide it to the soil. In other aspects, however, our laboratory analyses found satisfactory levels of organic carbon and bioavailable soil nutrients, low contamination with (micro-)plastics, and the presence of heavy metals below admissible levels (except for cadmium and chromium) in both municipal composts as well as in two community composts (Fischer, 2021; see also Temgoua et al., 2014).

In any case, demand for Dschang’s municipal compost is high; the whole production can be sold, including to commercial farms and corporations in other regions of Cameroon. Sales have risen from 60 tons in 2015 to 149 tons in 2020 (AMGED, 2020).

Finally, the centralized waste facilities in Ngui and Siteu have faced NIMBY-like opposition. Communities living near the platforms – one is located within a settlement and the other one only 30 meters away from a primary school – complained about the smells and filed written complaints to the mayor on the grounds that their wellbeing has not been considered. Grievances also reached the local delegate from the central Ministry of Environment, Nature Protection and Sustainable Development, who maintained that he is not able to intervene in this municipal matter but conceded that no proper environmental impact assessment was carried out before the establishment of the platforms (Interview, 2/09/2020).

High labor costs and conflictual relationships at the processing facilities have motivated AMGED and other local organizations to reflect on how waste segregation at source could be promoted. However, the municipality has not supported these initiatives in a substantial way yet because of political reasons (see section 4.4).

4.3.2 Challenges of extending waste collection: conflicts and competition

To increase municipal compost production and to extend garbage collection to less accessible areas of the city, AMGED established partnerships with three local civil-society organizations (“associations”) in 2016. Each of these associations is required to collect 64 tons of waste per month and transport them (on tricycles) to the composting platform in Ngui (AMGED, 2020). This system is called “participatory pre-collection”, meaning that voluntarily participating households pay a monthly fee of FCFA 500-2,000 (US 0.80-3.20 \$). The prepaid amount depends on the size of the household and the quantity of waste produced. Between 2016 and 2020, the number of registered households rose significantly from 1,111 to 1,960 (AMGED, 2020).

However, conflictual relationships have emerged between pre-collectors and some households that led to the intervention of AMGED on a few occasions. The director of a pre-collection association complained that “many households do not respect their engagements. We collect their waste and they either refuse to pay or they pay whenever they want” (Interview, 02/07/2020). Some registered households have become less inclined to pay the fees as they increasingly believe that waste collection would be the responsibility of the municipality. The head of a household said: “I cannot continue to pay for waste collection. They collect our waste, compost it, and sell it to us as compost” (Interview, 05/07/2020). The valorization of waste by the municipality has unwittingly contributed to a reduced willingness to pay for waste collection.

The extension of waste collection to less accessible areas faces additional challenges because of competition and conflict between the three pre-collection associations. Although each association has been allotted a particular zone of the city, there are no regulatory restrictions for them to seek

subscriptions from households elsewhere. Consequently, they scramble for subscribers in the more central and accessible parts of Dschang (Interview with the coordinator of a pre-collection association, 02/07/2020) thus hindering the improvement of waste collection in peripheral and less accessible parts of the city.

More generally, the inclusion of civil-society organizations in Dschang's formal waste management and the ensuing conflicts between pre-collection associations and households have complexified the power relations around waste collection. This can complicate the promotion of waste segregation at source (Cornea et al. 2017b). The monetization of the system has also started to change social norms (reduced sense of responsibility) that may hinder the recruitment of waste sorters at the household level in the absence of economic incentives.

4.4 Political obstacles to waste segregation at source

In Cameroon, waste management is guided by various laws, decrees and orders (Albrecht et al., 2022), but the legal framework is largely ineffective and hardly enforced (Asong, 2010, Manga et al., 2007; Albrecht et al., 2022). While the National Strategy of Waste Management (2007) recommends waste segregation, selective waste collection, and composting, for example, the related implementation decree of 2012 does not provide any specific rules on these points. Furthermore, the involvement of municipalities and a multitude of ministries (urban development, environment, public health, and decentralization) has created confusion and conflict around municipal waste management (Manga et al., 2019).

Despite having pioneered organic waste management in Cameroon and the discussed challenges of centralized composting, Dschang Municipality had at the time of our fieldwork in 2020 not developed any policy for waste segregation at source or implemented any system of separate waste collection either. The representative of AMGED ascertained that the municipality has not allocated any funds or put in place any strategy to encourage waste segregation at source. According to him, elected councilors are reluctant to introduce mandatory segregation at source because of fear to lose political popularity (Interview, 2/11/2020). Instead, the municipality set up a half-automated waste sorting system in 2021; a machine aids waste segregation at the Siteu platform but fails to function effectively because the voltage is too low.

Pre-collection associations have also failed to introduce separate waste collection of biodegradable and non-biodegradable waste, which would compel households and restaurants to sort waste. The associations lack the resources to acquire and distribute the required dustbins and to motivate the households to start waste sorting. A representative of an association reported that the support from AMGED is insufficient to introduce separate collection and segregation at source (Interview, 13/08/2020). A representative of another pre-collection company pointed to insufficient economies of scale stating: “[We] have not been able to implement source segregation and could only do so if we get up to 1,000 registered households” (Interview, 05/07/2020). Furthermore, the competitive relationship between the three pre-collection associations hinders the introduction of

separate waste collection: if an association introduced this system on its own, it would risk losing clients to the other two associations. As we have seen, households are already reluctant to pay user fees for pre-collection, seeing that municipal garbage collection in the central parts of the city is free of cost). It is therefore difficult for the associations to ask households to sort waste on top of paying for the service.

Furthermore, there are institutional disincentives to composting at a more general level in Cameroon. A representative of AMGED explained that the national policies regarding farm inputs have made compost unattractive as a fertilizer despite efforts made by municipalities and NGOs to promote compost use. He added that national policies have created disincentives for the adoption and use of compost (Interview, 11/05/2020). An agricultural extension officer further explained that synthetic fertilizers were subsidized at almost 50% between 1990 and 2001 and that the central government still does not tax mineral fertilizers nor raise tariffs on their importation (Interview, 22/08/2020). For instance, Law No.2003/007 of 2003 on the fertilizer subsector allows the importation of chemical (mineral) fertilizers with preferential tariffs and it facilitates private investments in their production through fiscal incentives. Today, mineral fertilizers are imported and promoted locally by agents of multinational companies in collaboration with state agents and agricultural extension officers while there is no state support for the production and use of compost. Consequently, the use of chemical fertilizers is more widespread than that of compost in Cameroon, especially among large-scale farmers.

Against this backdrop, the efforts by Dschang Municipality and local NGOs that promote compost use have limited impact. Yet, AMGED has introduced the production of “agro-compost”, a mixture of waste-based compost (75%) and fowl dung (25%), based on observed practices by farmers. This has attracted new clients who used to be reticent to municipal compost use (AMGED, 2020). Furthermore, the *Groupement d'Appui pour le Développement Durable* (GADD), a local NGO promoting organic agriculture, has encouraged farmers to adopt composting and compost use and therefore waste segregation. They have set up a local certification system to ensure the quality of organic products and the respect of good agricultural practices (Tailly, 2022).

5. Discussion and Conclusion

Our findings from Dschang resonate with the UPE literature on waste in at least two ways. First, they show how waste management contributes to the reproduction of socio-spatial inequalities (Véron et al., 2018). As in many other sub-Saharan cities, the urban metabolism of waste in Dschang reproduces uneven urban space: while in central areas waste collection is organized by the municipality free of cost, in less accessible parts private associations are employed to offer pre-collection services against a user fee, and in remote zones waste is often dumped in the environment. This raises the problem of inequality and discrimination in the provision of public services.

Second, our case study confirms that solid waste management is as much a political(-economic) as a technological matter (Véron et al., 2018). For instance, municipal composting in Dschang faces economic challenges that are due to limited segregation at the level of households and restaurants leading to high labor costs for centralized waste sorting. At the same time, national-level policies do not provide support and are biased against the production of compost as a fertilizer. Furthermore, the competitive relationship between the pre-collection associations as well as micropolitics at the central composting platforms, involving tensions between the management and employees and between male and female waste workers, affect the efficiency of the organic waste management system. The establishment and expansion of municipal composting plants also face opposition from neighbors. Finally, even at the intra-household level, waste practices are shaped by gendered and age-related power relations – between men and women, adults and children, boys and girls.

Political economy and micropolitics influence segregation at source, which is an important condition for efficient organic waste management (Viljoen et al., 2021). Using SPT and learning from existing informal practices, furthermore, our study points to both obstacles and multiple ways how waste segregation at source can be encouraged –or how waste segregation can find recruits among households and restaurants.

First, at the level of material arrangements, the introduction of separate waste collection is an effective way of fostering organic waste segregation at source in developing countries (Trois and Simelane, 2010; Fernando and De Silva, 2022). However, our case study confirms findings from India (Cornea et al., 2017b) that pushing residents to segregate waste through the introduction of separate waste collection is politically unpopular. In the case of Dschang, the initiation of separate waste pickup is further impeded by complex institutional arrangements (multiple private and public organizations, different pricing).

Second, and still related to material arrangements, existing practices in Dschang show the importance of kitchen space and of having multiple waste bins to enable organic waste sorting at the household and restaurant level. However, the municipality and the pre-collection associations seem to lack the financial resources to acquire and distribute waste bins to households in denser areas of the city and to promote waste segregation in that way. In these areas, kitchen space is often limited as well.

Third, in terms of social norms, our findings suggest that waste segregation in Dschang is mostly utilitarian. Organic waste sorting is undertaken mainly for economic benefit (a factor generally underplayed by SPT but found very relevant in the case of Dschang) – with the purpose to sell or use waste as animal feed or for composting – but in some cases also done for social reasons (e.g., supporting a relative or a neighbor). Thereby, knowledge and skills do not appear as an important limiting factor. However, opportunities to use, sell or gift organic kitchen waste are limited for most households that are located in the denser parts of the city and it is unlikely that the informal market for waste used as animal feed can expand much beyond the level of (larger) restaurants.

Waste-based pork farming is also criticized by local veterinary scientists for increasing sanitary risks (Kouam et al. 2020).

Finally, the situated analysis using a combined UPE-SPT approach leads us to formulate policy recommendations to overcome some of the above-mentioned obstacles for organic waste segregation at source and to improve solid waste management in Dschang, Cameroun and sub-Saharan Africa more generally. Rather than replacing the informal waste management practices related to animal husbandry and composting, policies should strengthen this sector, for example, by providing skills training to farmers to ensure that waste-based pig rearing is consistent with sanitary standards and to improve farm-level composting techniques. To promote organic waste segregation at source in more urbanized areas, the introduction of separate waste collection appears key. The social and political acceptability of this measure may be increased through the distribution of waste bins and economic incentives, for example, through common reduced or waived collection fees. Additional costs for the municipality can be compensated in part through reduced labor costs at central composting facilities, but a shift of the overall policy framework from supporting chemical fertilizers towards promoting compost production and compost-based agriculture seems equally necessary to improve financial sustainability.

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