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Title of the paper

Participatory urban solid waste governance in the global South*

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Abstract

Worldwide urban waste management is a critical public service that if lacking or deficient creates serious problems, affecting the sanitation, public health and general living conditions in the city as well as contributing to global warming and even impacting the wider marine and terrestrial ecosystems. Furthermore, inadequate waste management and lack of waste reduction measures contribute to the waste of natural resources and the contamination of the environment and can further also affect the livelihoods of those who depend on the collection of recyclable materials. Waste governance is emerging as transdisciplinary and inter-sectoral approach to waste management and policy, moving away from a primarily engineering and prescriptive perspective. Waste is more than a sanitary or health problem to be addressed with technological solutions only. The process of governing waste involves the articulation of different structures, institutions, practices and actors. Issues of power, scale, and equity are equally important. Innovative forms of governance are emerging as decentralized, participatory and inclusive, focused on waste reduction and resource recovery. With this article we aim to provide practical knowledge on the contributions of grassroots organizations and networks in waste management, supporting the discussion of good waste governance in specific city contexts. We bring a wide variety of experiences where different forms of waste governance are practiced to showcase their assets and to discuss prevailing challenges. We are informed by a situated urban political ecology perspective, allowing us to address everyday issues of waste generation, management and governance in Brazilian cities and in other parts of the world.

Keywords: Environmental governance, waste management, household waste, waste picker organizations, networks, Brazil

1. Introduction: Waste management challenges in global South cities

Given today's unsustainable production and consumption patterns, of which global warming and its environmental impacts are a consequence, environmental governance plays a key role, involving all scales: global, national, regional and local as well as all sectors from government, and business sectors to civil society at large (UN Environment, 2019). Environmental problems have always been complex and closely related with other policy areas (Jordan & Lenschow 2010), however Adelle and Nilsson (2015) considered that the efforts to overcome the separation and boundaries as a result

of sector approaches in governance have not made sufficient progress. It is now more important than ever to promote the integration and coordination of environmental concerns with other areas, such as the economy, trade, health, water, energy, transportation, education, advertising, food systems and urban planning (FAO, 2015; Le Blanc, 2015; Elder, Bengtsson & Akenji, 2016; Scheyvens *et al.,* 2017; UN Environment, 2019).

Good governance and the sustainable management of solid waste links up with all of the 17 Sustainable Development Goals (SDGs) established under Agenda 2030, but specifically goal number 12 proposes to ensure sustainable production and consumption patterns and target 12.5 specifically demands a substantial reduction of waste generation through prevention, reduction, recycling and reuse, by 2030 (ONUBR, 2015). This requires consolidating a multi-scalar governance approach and the alignment of international, national and local actions (UN Environment, 2019). Sustainable strategies through packaging design and product lifecycle, for example, that aim to reduce the impacts on natural resource extraction, can promote a 10 to 15 per cent reduction in global greenhouse gas emissions just from recycling and improvements in solid waste management, and between 15 and 20 per cent by including measures to prevent or reduce the production of waste (Wilson et al., 2015:12).

Globally, cities generate between 7 and 10 billion tonnes of waste per year. This amount is expected to rise and even double by 2030, particularly given the rapid urban growth rates in lower-income African and Asian countries. Wilson et al. (2015) who conducted a joint UNEP/ISWA study estimate that 3 billion people worldwide living in cities are still lacking waste collection and access to adequate waste disposal facilities, which poses severe health risks (infections, exposure to chemicals, dust) and environmental impacts (soil, air and water pollution, GHG emissions).

The global North has developed their waste management systems to the point where some countries are more likely to adapt their system to integrate new and complex waste types; driving more responsible consumption and production patterns; moving towards near zero waste schemes and circular economy. The global South on the other hand is still grappling with basic waste management challenges, including open dumps, uncontrolled dumping, open burning and inadequate access to waste services, particularly in informal neighbourhoods (Wilson, *et al.*, 2015).

Waste pickers, the major recycling force in the global South, often work under unacceptable conditions, particularly those who operate in dumpsites (Wilson et al., 2015;

Duan, Li & Liu, 2017). An estimated 15 to 20 million people are operating globally as waste pickers, many of them in dumpsites (Binion & Gutberlet, 2012; ILO, 2013). These workers are exposed to severe health risks, including exposure to chemical hazards, infections, musculoskeletal damage, poor mental health among others (Binion & Gutberlet, 2012). Accidents happen almost daily involving the heavy machinery operating at dumpsites while a large numbers of waste pickers is trying to salvage as many materials as possible; constantly being aware to not become overrun by the machines. The UNEP/ISWA study reported in the first seven months of 2016, an estimated 750 people who had died due to poor waste management at dumpsites (Wilson et al., 2015). While the global North chases the ideals of reduced waste, a strong circular economy and greater resource efficiency, the global South has to deal with everyday issues of poverty livelihood subsistence, pollution, health implications and environmental degradation, or littering; these regions must not be left behind.

A key step towards reducing the environmental and health impacts of domestic waste is to shift the perspective of waste from regarding waste solely as a health and environmental threat to seeing it also as a resource and source of raw materials (Wilson et al., 2015). In the global South, waste recovery activities are only or primarily performed by waste pickers (Medina, 2000; Wilson et al., 2006, 2012; Chaturvedi, 2009; Samson, 2009; Scheinberg, Simpson & Mol, 2011; Linzner & Lange, 2013; Gutberlet, 2008; 2016). Few cities in the global South have formal selective waste collection systems in place, and most of these are being carried out as co-production between the formal (mostly the public waste management) and the informal sectors (waste picker cooperatives, associations, small entrepreneurs, etc.) (Gutberlet et al., 2017; Jaligot et al., 2016; Sembiring & Nitivattananon, 2010; Wilson et al., 2012). We argue that there is a great potential to improve and expand selective waste collection and recycling in the city, with the inclusion of waste pickers. However, this requires recognizing and remunerating the services they provide and provide supporting public policies that facilitate their work (Jacobi & Besen, 2011).

In the next section we will define waste governance from an environmental governance perspective, embedded in a situated urban political ecology theoretical framework. We will then introduce different forms of organizations and networks under which waste pickers operate in different countries in the global South. We will briefly describe our research methodology and epistemology and then focus on the context of waste picker cooperatives and networks in Brazil. Research results will then highlight

some of the social innovations in waste management and governance that we have encountered in these grassroots initiatives. Finally, we reflect on the assets waste picker grassroots organizations bring and the challenges they face to enhance participatory, environmental governance aiming at inclusive, separate waste collection and the introduction of the many diverse materials waste pickers recover into the circular economy.

2. Waste Governance

The growing amounts of waste generated in cities worldwide and the increased disparity in waste management within cities and across regions are consistent challenges of global concern. Waste management is a critical public service and waste that is not collected, but rather informally dumped or burned, creates serious environmental problems, affecting the global community by leaking into lakes and oceans, contaminating soils and animals, and by generating GHG emissions that affect the climate.

Waste governance takes a transdisciplinary and inter-sectoral approach to waste management with a focus on policies and regulations, as well as institutional arrangements that delimit how decisions are made, who participates in the deliberations and how work is carried out. Thus, from a waste governance perspective, we are moving away from a primarily engineering and prescriptive methodology (Bulkeley et al., 2005; Moore, 2012). While waste produces sanitary and health problems it is a more complex issue that cannot be addressed only with technological solutions. Good waste governance requires the reconceptualization of waste as a resource, takes an inclusive approach to waste management that allows the participation of different grassroots waste actors (waste pickers, small scale waste entrepreneurs, community-based organizations, non-governmental organizations, etc.) and that encourages innovative approaches to prevent the generation of waste and wasted resources.

The process of governing waste involves the articulation of different institutions, structures, practices and actors; and issues of power, scale, and equity are very important in shaping the outcomes. Innovative forms of governance are decentralized, participatory and inclusive, focused on waste reduction and resource recovery. Good waste governance also addresses: poverty reduction, builds community resilience, tackles climate change and increases environmental sustainability; besides working towards reduction, reuse and

recycling.

In the global context, integrated and sustainable solid waste management is one of the biggest environmental and urban challenges (Hoornweg Bhada-Tata, 2012), regardless of city size and political priority (UN - Habitat, 2010). The diversity of materials in solid waste and their specific forms of management makes governance more complex, insofar as it also involves different segments of actors. The separation between the organic and the inorganic matter, at the source, is indispensable for the collection and separation of recyclable waste (and to reuse the organic fraction for composting of biogas generation). Up to 70% of the household waste produced in the global south is organic (Wilson et al., 2012; Gutberlet 2016) and yet there are very few cities that have a formal organic waste collection system in place (Yates & Gutberlet, 2011). In most cases this material is landfilled or dumped and becomes mixed in with inorganic waste. Under these circumstances the organic fraction generates liquid leachate, methane and other greenhouse gases, thus compromising environmental and human health. However, these materials can be recovered for the production of compost to fertilize the soil or to generate energy for heating and electricity (Gutberlet, 2016).

Food waste happens throughout the food production and consumption chain. It is also part of the organic waste and a significant component in household waste. Approximately one-third of the food produced for human consumption is wasted or lost annually, at a financial cost of US$750 billion to US$1 trillion (FAO, 2013; Wilson et al., 2015). However, this wasted food could feed over 2 billion people, more than twice the estimated number of globally undernourished people (FAO, 2013). Food losses and waste result in unnecessary greenhouse gas emissions, estimated at 3.3 gigatons of CO_2 equivalents in 2007, or around 9 per cent of total global GHG emissions in that year (Wilson et al., 2015). The latest UN Environment report (2019) urges for food waste to become a policy priority, underlining the necessity to include organic waste recovery in any local waste governance effort.

It is also important to consider that optimizing municipal selective waste collection reduces final disposal in landfills (Rada, Ragazzi & Fredizzi, 2013) which is crucial for large urbanized areas where land is scarce. In low- and middle-income countries, the participation of waste pickers formalized in cooperatives, associations or solidarity economy enterprises (also called membership-based organizations) (Besen et al. 2014; Gutberlet, 2015; Fei et al., 2016) is significant. In several Latin American

countries, their participation in municipal selective waste collection programs is of particular importance for their social inclusion and for circular economy results (Wilson et al., 2006; Asim et al., 2012; Velis et al., 2012; Scheinberg, 2012; Dias, 2016; Velis, 2017).

For Rutkowski and Rutkowski (2015) selective collection operated by waste pickers might be considered a successful social technology, but they warn that low and middle-income countries should consider cultural diversity and the lack of specialized technicians in municipal waste management in order to replicate the model. On the other hand, Gutberlet (2015) points out the persistence of social and economic exclusion of workers in the informal sector, the low payment for selective door-to-door collection, and limited financing sources for these groups, and thus a hindrance to effective and successful selective waste collection and recycling programs.

The state has an important role to play in strengthening environmental governance, by ratifying and implementing environmental conventions, promoting environmental research and supporting vulnerable populations (Ezea, Fazakerley & Roberts, 2013; Dias & Samson, 2016). Urban political ecology reveals economic and political power structures, policies and infrastructures supporting and maintaining waste management systems. This perspective has its roots in social theory – specifically in cultural studies and political theory (political economy) – and attempts to unveil relationships and interactions between society and the natural world (Heynen et al., 2006). The increasingly complex societal challenges related to environmental change most often lack an ethics of environmental justice and social change (Bryant, 1998). Urban political ecology tries to reveal and comprehend the intricate and multifaceted environmental and social impacts of human activities in the city. The approach politicizes understandings of the distribution or absence of resources, thus focusing on social and environmental injustices. We will take a situated lens of UPE, because it specifically considers the local historical and geographic global South context.

While greater multi-stakeholder participation in governance is a goal in environmental governance, there is a need for greater synergies between governments and civil society organizations (UN Environment, 2019). City and regional governments need to identify their local key stakeholders, including waste pickers, representatives of marginalised groups, representatives from city administrations, the private sector and local research institutes. There are benefits in collaborating with national government partners and other value chain stakeholders, in order to collectively constitute a Local

Governance Stakeholder group. This group has the mandate to advice on the design and implementation of projects and it represents the interests of the different stakeholders impacted by changes in policies and the waste systems. We will further discuss the proposed approach to governance in the regional context of the cities of São Paulo and Belo Horizonte in Brazil. The next section examines waste pickers grassroots network organizations in Brazil and their impact on waste governance.

3. Waste picker organizations and networks in Brazil

Waste pickers throughout the world organize in trade unions, associations, cooperatives, networks or other community-based organizations. Estimates for the number of waste pickers in Brazil vary between 400,000 and 600,000, depending on the source (IPEA, 2013). The 2010 census (IBGE, 2012) provides a number of 387,910 self-declared waste pickers. According to the IBGE census, almost 39 per cent of the waste pickers in Brazil are organized in membership-based organizations (cooperatives, associations). While 31 per cent of the waste pickers are female, the majority of the organized waste pickers are women. The average age of waste pickers is 39 years, the majority is Afro-descendent (66 per cent) and a significant number (20 per cent) is still considered illiterate. Only 25 per cent has completed their basic education (IBGE, 2012).

Organized waste pickers form a social movement which provides new formulations on how to deal with waste, how to promote participatory waste management and how to improve the livelihoods of waste pickers, disrupting existing assumptions and preconceived ideas about them. They are organized in the National recyclers' movement (*Movimento Nacional de Catadores(as) de Materiais Recicláveis – MNCR*). The movement is also part of the Latin American recyclers' movement (*RedLacre*) and the global network of waste pickers organization (*GlobalRec*). These organizations reject the unacceptable social and economic conditions under which informal waste pickers work, requesting policies and structures for inclusive solid waste management.

The national recyclers' movement MNCR was created by waste pickers in 2004, with the goal to expand inclusive solid waste management programs throughout the country and to integrate the struggle of the waste pickers for self-determination and inclusion in the praxis of handling solid waste, which also means better access to funding and credit lines. Since then, considerable transformations have happened, institutional structures and specific legislations have been created to assist the organization of the

waste pickers and to support their operations under the National Solidarity Economy. The recognition of waste pickers has increased significantly in the last decade. Since 2002, the profession of waste pickers has become legal. Several additional laws have been enacted since, in support of inclusive solid waste management and decent working conditions for 'informal' recyclers. The following Table 1 summarizes some of the public policies and actions, mostly initiated by the federal government, which have become instrumental in changing the working conditions of waste pickers in Brazil, creating opportunities for cooperatives to be included in the recycling chain.

Table 1: Brazilian Legislation supporting waste pickers activities

Law/Decree/Action	**Main objectives**
Federal Law No. 5,764 of December 1971	Establishes the National Policy on Cooperatives
In 2002, the Ministry of Labor and Employment creates the professional category: *catador* collector of recyclable materials and includes it in the Brazilian classification of occupations (CBOS), under the Code 5192-05 (MTE. Classificação Brasileira de Ocupações)	Legal and formal recognition of the occupation of collector of recyclable materials, setting parameters for the development of this activity.
Decree No. 5,940, 25 October 2006.	Requires public institutions to separate and donate the recyclable fraction of their solid waste to recycling associations and cooperatives.
Federal Law No. 11,445, of 5 January 2007: National Policy on Basic Sanitation	Authorizes the municipalities to hire recycling associations and cooperatives to collect, process and market recyclable or reusable municipal solid waste.
Federal Law No. 12,017 of August 2009 and published the annex VII of the D.O.U, 13.8.2009, extra Edition.	Changes the law of the budget guidelines, allowing the direct transfer of resources to cooperatives, without intermediation of municipalities or social organizations of public interest.
Federal Law No. 12,305, July 2010 and its regulation through Decree No. 7,404 of December 2010.	Establishes the National Solid Waste Policy and creates the Inter-ministerial Committee of the Brazilian solid waste Policy and the Steering Committee for the implementation of the reverse logistics systems.
Federal Decree No. 7,405, 23 December 2010, published in D.O.U. of 23 December 2010.	Institutes the *Pro-Catador* program. It creates the joint inter-ministerial Committee for social and economic inclusion of the collectors of reusable and recyclable material.
Federal Law No. 12,690, of 19 July 2012 published in D.O.U., 20 July 2012.	Rules on the organization and functioning of Workers' Cooperatives.

Source: Gutberlet, 2016

In 2010, the national government created the *Pro-Catador program* to help integrate and coordinate the actions of the federal government supporting waste picker organizations, with actions to improve working conditions and expand selective waste collection, reuse and recycling through the inclusion of waste pickers in Brazil. The fact that the federal law includes solid waste as part of sanitation has furthermore extended funding opportunities for this sector.

On the local level progressive legislation, such as the municipal law in Diadema that enables remuneration of waste pickers for the service of collecting recyclable household waste (municipal law 2.336/2004 and Decree 5.984/2005). Unfortunately, the current government in Diadema does not respect the law and, despite the mobilization of local waste pickers, payments have already been suspended for several years. There are other municipalities, such as Ourinhos and Ribeirão Preto in the interior of São Paulo and São Caetano do Sul, Guarulhos and Mauá in the metropolitan region of São Paulo, where waste pickers have achieved the service payment. Similarly, some municipal governments in Bolivia, Argentina and Colombia are also moving towards payment of the public service informal recyclers are providing by doing selective solid waste collection (Tavares Campos, 2014; Murakami et al., 2015; Rutkowski & Rutkowsky, 2015; Gutberlet, 2016).

The Brazilian waste management legislation makes a strong case defending selective waste collection of reusable and recyclable materials and supports the waste pickers in that activity. The PNRS encourages municipalities to hire cooperatives for selective waste collection. Nevertheless, with the advent of increased pressure to close landfills and quickly solve the surmounting problem of solid waste accumulation, local governments are attracted to waste incineration, often termed waste-to-energy projects, funded through public–private partnerships (Rodrigues, Azevedo & Gutberlet, 2015).

In Brazil, many waste picker groups have organized into networks, allowing them to collectively sell their materials and to coordinate other actions that enhance their capacity in the waste management sector. Solidarity networks of waste picker enterprises are a recent phenomenon in the literature and in the praxis of waste picker organizations (Mota, 2018). Tirado-Soto & Zamberlan (2013) consider that networks of waste pickers are a strategy that allows them to access credit lines and complementary resources, as well as better administrative practices (Boeira, Campos & Ferreira, 2007) resulting in added value to the recyclable material and thus making possible a better positioning in the productive chain, with direct access to recycling industries (Aquino, Castilho Jr. &

Pires, 2009). These linkages are commonly called networks of cooperatives, solidarity networks, 2nd degree cooperatives (when formalized) or waste picker enterprises. There are several waste picker networks that operate in the metropolitan region of São Paulo, some of them highlighted in the following section.

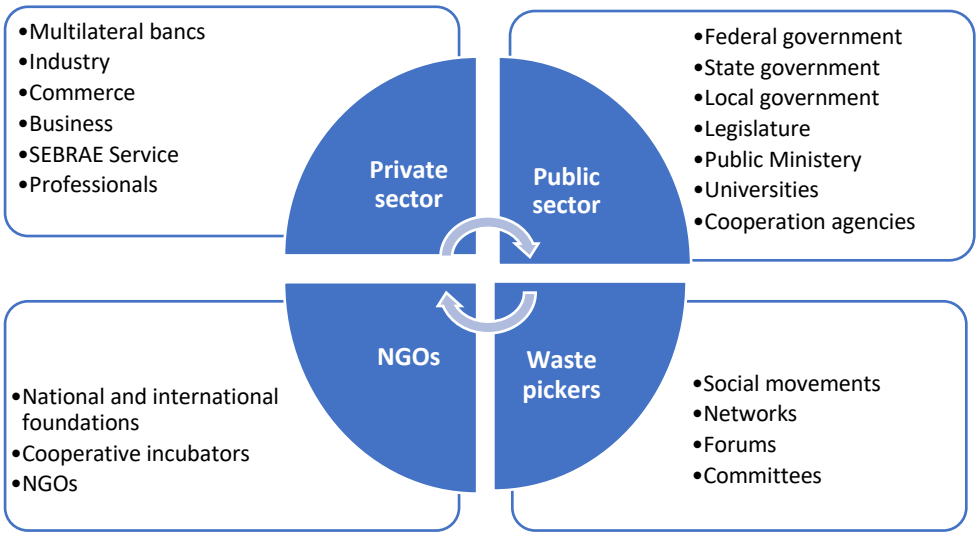
4. Innovative forms of inclusive waste governance

Innovative forms of environmental governance are decentralized, participatory and inclusive, focusing on waste avoidance and reduction, minimizing waste leakage, maximizing resource recovery and reintroducing materials into the circular economy. We will now introduce the case of the city of São Paulo, where a collective approach to waste governance was taken in the recent past.

The Brazilian National Solid Waste Policy (PNRS) has established several targets for the reduction of waste disposal at landfills, as of 2014 (Brazil, 2010; Tavares Campos, 2014). However, most of these targets have not been attained yet. It is estimated that from a total of 170,000 tons of urban waste collected every day in Brazilian cities, only 1.8 per cent, equivalent to 7.1 per cent of the household waste, is recovered and recycled by municipal selective waste collection (Brazil, 2017). On average, only one in three municipalities have implemented selective waste collection, with different levels of coverage (Brazil, 2017). The PNRS supports and prioritizes public resources for selective waste collection with the socio-productive integration of waste pickers, organized in cooperatives and associations (Aparcana & Salhofer, 2013; Ferri, Chaves & Ribeiro, 2015; Besen & Fracalanza, 2016).

In Brazil, the challenge of reducing the generation of waste and managing the over 180,000 tons of municipal waste that are produced every day by its 5,565 municipalities, requires integrated public policies that are articulated between the main actors and it involves efficient management systems that incorporate transparency and accountability geared towards building co-responsibility among the citizens (Reis, Conti & Correa; 2015; Jacobi & Besen, 2017). The following figure (Fig. 1) shows the diversity of actors involved in the processes that support the socio-productive inclusion of waste pickers in selective waste collection in Brazil.

Fig. 1: Actors of the socio-productive inclusion of waste pickers



The study of Dias and Samson (2016) showcases some experiences of transformative modes of waste governance in various cities in Brazil. The research demonstrates how important government funding (grants, microcredit) is, acting as a cushion to fall back on, particularly during times of instability and low income. The study shows how the lack of such programmes adds layers of vulnerability to the life of these workers. The authors identified main factors that support waste pickers in different contexts of formal integration into solid waste systems and the various roles government (at all levels) plays in inclusive waste management.

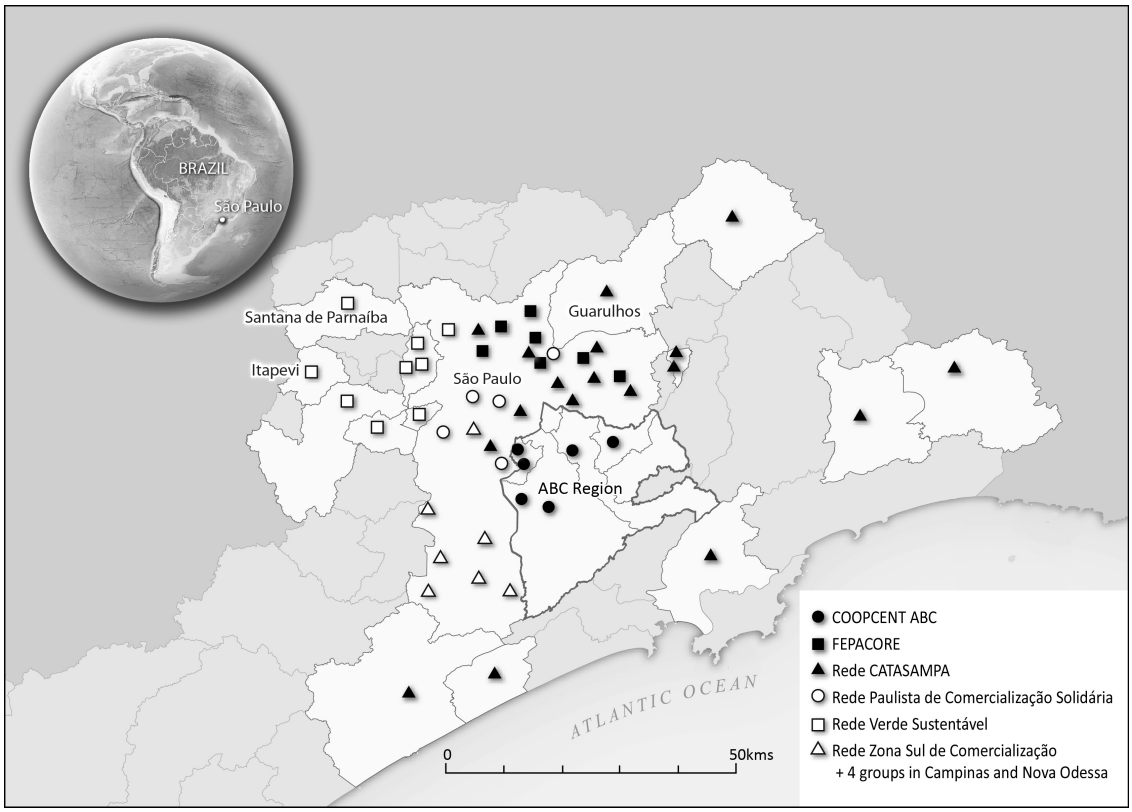
The discussions on public policies unveil gains and setbacks, indicating that a constant reinvention by the political actors is required. It is quite impressive to see that formal integration of waste pickers still happens in the city of Belo Horizonte, after 21 years. In Dias and Samson's findings from focus groups and key informant interviews we learn that this is mainly due to two factors: 1) the power of the organizing process in the city (the membership-based organizations are all active participants in the national movement of waste pickers and also participate in many socio-governmental platforms), and 2) the commitment of dedicated officers at the municipal sanitation agency who pressure the mayor's office to continue with inclusive solid waste management policies (Dias & Samson, 2016).

Qualitative research conducted mid 2018, by one of the authors, under the Mapping Waste Governance project (Azevedo et al., 2018), interviewed the National Waste Pickers movement (MNCR) as well as six waste picker networks in the metropolitan region of São Paulo (see Figure 2). The in-depth interviews were conducted in the administrative unit of the network, or in the cooperative to which at least one of the leaders was affiliated. The interviews were open ended, took between 2 and 3 hours on average and were taped. In all interview sessions (except for CATASAMPA) several representatives of the network were present at meeting. The interviews followed a thematic structure focused on the history of the network, their scope, their main objectives and methods, as well as information related to social innovations. The map provides the approximate location of the cooperatives part of each network. As we can see, some networks are quite widespread, and even have members that are located further away. This illustrates the fact that these networks are also based on human relations and affinities. This also means that not all members necessarily have to participate in collective commercialization, but they receive other benefits and supports from the network.

Rede CATASAMPA (2006) was the first and COOPCENT ABC (2008) the second network to be formally established. The other networks while they might have operated earlier, were formally created after 2012. Some networks are very large. Rede Paulistana (41 members) and Rede CATASAMPA (20 members) are the largest networks, while the others have between 7 (COOPCENT ABC) and 15 members (FEPACORE). All networks mentioned that their main objective for initiating the network was collective commercialization. However, all interviewees listed many other aims and benefits deriving from the network, including capacity building (related to cooperatives, work safety, waste management policy, technical issues, e.g. related to minimizing waste during material separation, etc.), developing joint projects and apply for funding, providing seminars to the wider community and to residential housing communities, informing and answering specific questions e.g. related to the pricing of the materials and helping with internal conflict resolution, inspecting the cooperatives to verify whether they are following the rules and principles set by the cooperative movement, consultancy (e.g. to the local government or business organizations on waste management). Some networks, such as Rede CATASAMPA, provide assistance to other cooperatives that are not yet well organized and still work under precarious conditions (e.g. the building and/or space is rented, no paved floor, or no proper protection from rain

and sun). Furthermore, the networks are able to engage in public policy design and as a network have much more bargaining power to negotiate contracts for individual cooperatives with their local governments.

Figure 2: Localization and extend of waste picker networks and their members in the metropolitan region of São Paulo.



Mota (2018) who studied three waste picker networks in the state of São Paulo also concluded that networks are generally born with a commercial focus and then evolve to other purposes and benefits. While it is not a positive aspect for cooperation to be limited to instrumental and economic purposes, the fact of starting joint activities with a concrete and commercial focus seems to facilitate the groups' consolidation. Networks are configured as an important organizational arrangement in the face of the complex challenges presented by the recycling market. National programs such as the national government's program *Cataforte* or specific funding provided by Banco do Brasil Foundation, the National Secretariat of Solidarity Economy – SENAES (extinct in 2016), or Petrobras were instrumental in the work of the networks supporting their affiliated waste picker cooperatives.

Important social and technical innovations have come out of these networks. For example, Rede Solidária CataVida has started a Polymer factory and have adapted a process to transform cooking oil into soap and animal feed. The leader reiterated the importance of waste pickers to add value and to not just collect and separate materials, and yet it seems difficult to convince the members to make products of higher value. Some cooperatives have left the network already because they prefer to be paid immediately when they sell their materials to intermediaries, while selling collectively takes up to 15 days to receive payment. Nevertheless, collective commercialization can obviously improve earnings significantly. Rede Solidária CataVida for example sells white High-Density Polyethylene (PEHD) at R$ 1.80 to the industry, while the middlemen are paying only R$0.50 to R$0.80. The largest challenges currently are related to the implementation of their innovations and is linked to the lack of sufficient recyclable materials (due to more competition, also due to the creation of new small to medium scale recycling industries) and the lack of working capital to be able to pay the cooperatives immediately for their materials.

Rede CATASAMPA also mentioned as social innovations their selective waste collection service provided to the public and private sectors as well as the provision of certificates of destination for the recyclables. In Mogi das Cruzes, for example, Rede CATASAMPA provides service to the municipal recycling program *Reciclamogi*. The program survived the change in government after local elections, which demonstrates resilience and the ability of the network to provide high quality service. The waste pickers involved in the program receive a fixed value for the collection and sorting based on operational costs. The workers further benefit from subsidized transportation, food, health coverage, holidays, paid annual leave, etc. The monthly income is around 1 minimum salary plus benefits. Even considering its configuration as a very recent phenomenon and lacking a deeper understanding, it is possible to affirm that due to the spontaneity in the rise of the network, the voluntary membership, and the fact that waste pickers are promoting cooperatives and self-management are essential for the consolidation of networks (Tirado-Soto & Zamberlan, 2013).

Although the main result of the literature shows that collective commercialization is able to cope with the challenges posed by the recycling market, network articulation is not limited to joint marketing in its range of benefits provided by the network (Pisano et al., 2019). The different arrangements showed large potential to strengthening the already well-developed social capital of the cooperatives within the network, as well as a deeper

understanding about the reality itself, making the networks seek the best alternatives to strengthen their enterprises, be it by selling directly to the industry, by providing services or capacity building activities, by exchanging knowledge leading to political strengthening, or by helping in the negotiation of co-production.

The research made it possible to understand that collective commercialization is an important starting point for the beginning of the articulation between waste picker organizations and local governments (Azevedo et al., 2018; Pisano et al., 2019). By being a concrete and tangible goal, collective commercialization facilitates the establishment of meetings and discussion spaces and the development of joint goals. The evolution of such discussions and the ripening process in itself end up evidencing when the collective commercialization is indeed interesting for the cooperative and when insisting in collective commercialization ends up becoming a hindrance, not bringing economic benefits to the groups. The practice of the network itself eventually evolves into more complex benefits, insofar as they are less palpable and perhaps more difficult to understand. However, our results clearly demonstrate that the political role of networks seem to be significant to promoting inclusive environmental waste governance.

The networks are configured as an important organizational arrangement in the face of the complex challenges presented by the recycling market. Considering the growing economic interest and the inclusion of new players in a previously undervalued market, it makes the organization of the waste picker cooperatives into cooperation networks an option for a better positioning of these workers in the field of reverse logistics (Besen & Fracalanza, 2016).

5. Final reflections: Towards inclusive environmental waste governance

Social and technological innovations since the late 1990s have introduced important changes to waste governance, particularly with new forms of organization, such as waste picker cooperatives, associations or networks, new models in waste management have emerged. Similar developments are happening in other countries in the global South, particularly in Latin America and Asia, and more recently these experiences are also diffusing into African countries. More prominently from 2010 on, waste picker networks have started to play an important role in promoting urban cleaning, selective waste collection, environmental education and redirection of recyclable materials into the circular economy. This has been demonstrated for Brazil, with the cases of São Paulo and

Belo Horizonte. The work of organized waste pickers is also important in achieving some of the SDGs of the Agenda 2030, particularly in view of reducing waste disposal, tackling poverty reduction and expanding social inclusion.

Despite the many difficulties and constraints attached to co-production in waste management, there are obvious gains for city administrations, communities, the waste pickers and the environment. Innovative experiences and co-produced arrangements demonstrate these opportunities and multiple social, economic and environmental benefits for the cities and their populations. Waste pickers, who usually are the most socially and economically excluded, have the opportunity to work in a collective setting, which is self-managed and guided by principles of cooperation, solidarity, equity and reciprocity. Cooperative members engage in education and training activities that also benefits their human development. With their work, they help to diminish the leakage of waste into the environment and the oceans as well as the waste of resources, which also reduces the need for further natural resource extraction. All these aspects ultimately benefit communities and build resilience (Gutberlet, 2016).

Yet, the most successful cases of cooperative recycling are those with institutionalized co-production, where local governments sign a contract with organized groups of waste pickers, for them to formally execute the selective waste collection and where they are paid for the service provided. Public policies formalizing these inclusive arrangements are crucial to guarantee a successful and lasting programme. Legislation has the potential to safeguard co-management arrangements, beyond party politics. A shift towards integrated, collaborative environmental governance is vital to make the co-produced service of waste management work. Among the social innovations that emerge from membership-based waste picker organizations and networks we have studies a few, which involve technological innovations (e.g. the polymer recycling industry or the soap production) and governance innovations stemming for skillful, successful forms of running a cooperative or network, as demonstrated here for the metropolitan region of São Paulo.

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