

Supplementary Material

The role of informal waste management in urban metabolism: A review of eight Latin American countries

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Photographic material on the activity of waste pickers and organizations in the study countries.



Figure S1. Argentine waste pickers. Source: Photo by the Argentine Federation of waste pickers (accessed online in 2018 <https://distintaslatitudes.net/historias/serie/reciclaje/recicladores-pandemia-guatemala-argentina>)



Figure S2. 'Catadores' (waste pickers) in Brazil. Own source from images published on international networks. (<https://distintas-latitudes.net/historias/serie/reciclaje/recifavela-brasil> <https://globalrec.org/> <https://www.google.com.mx/url?sa=i&url=https%3A%2F%2Fglobalrec.org%2Fpt-br%2F2020%2F10%2F20%2Fcampanhas-de-solidariedade-para-coletar-dinheiro-para-pessoas-catadoras-em-tempos-de-coronavirus-doe%2F&psig=AOvVaw0iL1cYU-bh8Jx2Cv2HGEI7&ust=1619809588562000&source=images&cd=vfe&ved=2ahUKEwj63KeKk6TwAh-VCRawKHT3FDxsQr4kDegQIARBi> y en Latitud R <https://latitudr.org/>)



Figure S3. Waste pickers in Chile [images from Chilean organizations] (Anonymous, 2020, 2021; Poo, 2021)

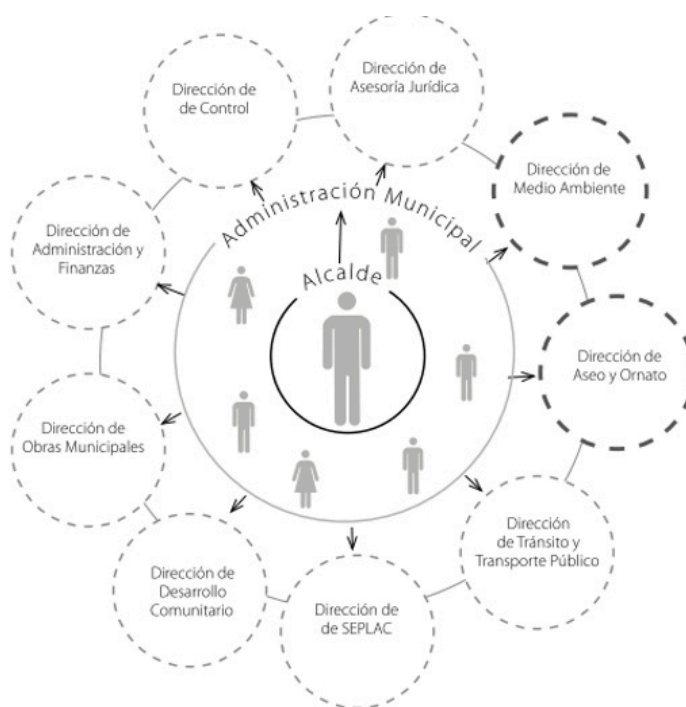


Figure S4. The proposed organizational structure for the management of so-called inclusive recycling (taken from the working document entitled Modelo de gestión de reciclaje inclusivo Región metropolitana, 2016) (Seremi del medio ambiente de la Región Metropolitana, 2016)

For more than 20 years, Exequiel has fought tirelessly for the rights and recognition of grassroots waste pickers. This year, he received recognition by winning the first 'Desafío Tierra' award for his contribution to environmental care (Figure 3). The law is structured around local institutions, waste diagnosis and characterization, waste transport/recovery, recycling infrastructure, business models, and financing channels. In Figure 4, the diagram summarizes the sequence of inclusive recycling in Santiago de Chile (SEREMI del Medio Ambiente de la Región Metropolitana de Santiago de Chile, 2012).



Figure S5. Waste pickers in Colombia in 319 organizations in 27 departments. Archive photo (Stern, 2016)



Figure S6. Work activities of waste pickers in Colombia. Archive photo (Stern, 2016)

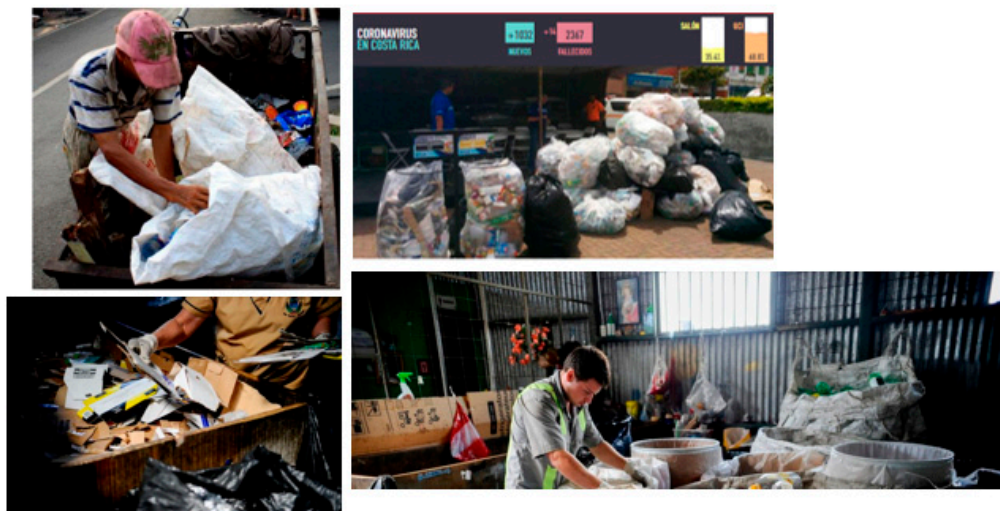


Figure S7. An initiative to improve the quality of life of grassroots waste pickers in Costa Rica <https://www.revista-perfil.com/vida/cultura/reciclaje-en-costa-rica-la-mision-de-convertir-la-basura-en-la-salvacion-del-planeta/OAIBI6YVFNFMXE7CNCIS6WU7A4/story/>



Figure S8. San Rafael Heredia, Costa Rica: Grassroots Waste Pickers' Collection Centre (Hernández, 2020)



Figure S9. Citizens' initiative in Ecuador: ReciVeci (2017)



Figure S10. Legal Organization in Ecuador: Axes of the National Network of Waste Pickers of Ecuador (<https://renarec.com/quienes-somos/>)



Figure S11. Second International Smart City Ecuador Congress "Quito to recycle" (Rodas, 2018).



Figure S12. Photographs of the Foro Nacional de Reciclado Inclusivo, FNRI, hosted by the Senate of the Republic in México City (Foro, Sobre, and Inclusivo, 2019)



Figure S13. A photograph was taken from a report (Espinosa and Parra, 2019): "A waste picker without waste is a farmer without a field, a doctor without patients, a fish without water...a bird without a sky" http://www.wiego.org/sites/default/files/publications/files/CDMX2_Espinosa-Parra-Ciudad-Mexico-WPHR_ForWeb.pdf



Figure S14. Meeting of waste pickers from across the country in Mexico City. (Pansters and Berthier, 2020) <https://www.wiego.org/mexico-city>.



Figure S15. Photos alluding to the festivals initiated in 2008 in Mexico with the 1st International Recreational Recycling Festival, Cholula, Puebla, México (Creativo, 2017) [http://sic.gob.mx/ficha.php?table=festival&table_id=1158#:~:text=El Pepenafest es un punto,de los residuos sólidos urbanos.&text=Las actividades son%3Atalleres%2Cmódulos,visuales%3Bexpos%2C entre otras](http://sic.gob.mx/ficha.php?table=festival&table_id=1158#:~:text=El Pepenafest es un punto,de los residuos sólidos urbanos.&text=Las actividades son%3Atalleres%2Cmódulos,visuales%3Bexpos%2C entre otras.).



Figure S16. Waste Pickers' Associations in Perú "Asociación de recicladores Jesús María", Asociación Lima Norte "Juan Pablo II"

<https://www.cocacoladeperu.com.pe/historias/medio-ambiente-basilio-gomez--de-reciclador-informal-a-referente-del-reciclaje->,
<https://trome.pe/familia/lima-sur-recicladores-orgulloso-chamba-63684/> <https://compuempresa.com/info/asociacion-de-recicladores-juan-pablo-ii-los-olivos-20544969740>



Figure S17. Group of waste pickers from the association in the Peruvian district of Arequipa, where a UNDP-supported program has helped to organize workers, regulate them and expand their work (Photo UNDP, Perú). <https://www.pe.undp.org/content/peru/es/home/ourwork/environmentandenergy/successstories/ResiduosArequipa.html>

Table S1. Types of literature review in this paper

classification of readings and consultations	Number of articles inspected	Number of articles reviewed
journal articles	23	7
Books	3	
Manuals	6	
Thesis	1	
Newspaper	7	
Websites	22	
Standard	4	
International organizations /NGOs	11	
	77	7

Table S2. SOCIAL INCLUSION AND LEGISLATION

Country	Laws	ORGANIZATIONS
Argentina	Law 25.916. Household Waste Management (2004)	Argentine Federation of cartoneros, carters, and recyclers (FACCYR)
Brasil	Law No. 12.305/2010	14 Cooperatives of catadores
Chile	Law 20.920 for waste management	more than 20 cooperatives and organizations
Colombia	Districtal Directive No. 009 of 2006 Code SG/MIPG 127-PPPGR-04	319 organizations in 27 departaments
Costa Rica	Integral Waste Management Law No.8839 (Decree No. 35906-S, published in the official gazette La Gaceta La Gaceta Official Gazette No. 86 of May 5, 2010).	San Rafael Heredia, Grassroots Waste Pickers, Collection Center, and recycling collection center "El Molino."
Ecuador	National Program for the Integral Management of Solid Waste - PNGIDS ECUADOR	Ideal Dignity Foundation (FLA) National Network of Recyclers (RENAREC) Legal Organization in Ecuador: Axes of the National Network of Waste Pickers of Ecuador PepsiCo Ecuador
México	General law for the prevention and integral management of wastes	There are three organizations of waste collectors in Mexico City: San Juan de Aragón: "Asociación de Selectores de Desechos Sólidos de la Metrópoli A.C." (Association of Selectors of Solid Waste of the Metropolis). Bordo Poniente: "Frente Único de Pепенadores A.C.". Santa Catarina: "Unión de Pепенadores del D.F. Rafael Gutiérrez Moreno A.C.".

	Environmental Sanitation Engineering Network (REDISA)
	Waste pickers of Xochiaca
NMX-AA-019-1985 Protección al ambiente - Contaminación del suelo - Residuos sólidos municipales - Peso volumétrico “in situ”.	Although there is no exact figure on how many scavengers there are in Mexico, company members estimate that around 2.5 million and 90 percent of them work informally, without paying taxes, and without receiving social security like those who work with Deltarec.
NMX-AA-021-1985 Protección al ambiente - Contaminación del suelo - Residuos sólidos municipales - Determinación de materia orgánica.	
Perú	
Ley del Reciclador del año 2009 – Ley N° 29419	Tacna Perú
Law No. 27444, Law of General Administrative Procedure. (Article 87 of Supreme Decree n.º 014- 2017-MINAM)".	30% of waste pickers in Peru are women. -There are 105 women from 10 associations in Arequipa.
Law on Integral Solid Waste Management, D.L. N°1278	Waste Pickers' Associations in Perú “Asociación de recicladores Jesús María”, Asociación Lima Norte “Juan Pablo II”

References

- Ministerio de Ambiente y Desarrollo Sustentable (MAYDS)<http://servicios.infoleg.gob.ar/infolegInternet/anexos/95000-99999/98327/norma.htm>
- https://www.andi.com.co/Uploads/Nueva%20Pol%C3%ADtica_Ambiental_RESPEL%202022-2030.pdf
- <https://sgc.dadep.gov.co/7/3/127-PPPGR-04.pdf>
- <https://medioambiente.uxternado.edu.co/codigo-de-colores-para-la-separacion-de-residuos-solidos-en-el-pais-posibles-inquietudes-sobre-la-medida/>
- <https://www.ambiente.gob.ec/programa-pngids-ecuador/>
- <https://cuentame.inegi.org.mx/territorio/ambiente/basura.aspx?tema=T>
- <https://minae.go.cr/>
- <https://mma.gob.cl/>
- <https://sinia.minam.gob.pe/sites/default/files/archivos/public/docs/2093.pdf>
- <https://www.gob.pe/institucion/minam/noticias/487809-alrededor-de-93-mil-toneladas-de-residuos-solidos-fueron-valorizados-en-el-2020-a-nivel-nacional>
- <https://sinia.minam.gob.pe/novedades/peru-solo-se-recicla-19-total-residuos-solidos-reaprovechables>
- <https://renarec.com/quienes-somos/>
- <https://compuempresa.com/info/asociacion-de-recicladores-juan-pablo-ii-los-olivos-20544969740>
- http://municipal.cegesti.org/manuales/download_guia_reciclaje_inclusivo_informales/guia_reciclaje_inclusivo.pdf

Table S3. Shows the countries' statistical data on population, daily per capita generation, and municipal solid waste generated in the year. The rate of utilization and the amount recycled. It shows a low rate concerning the generation, which indicates the importance of differentiated collection at the source for better utilization of waste. This table was incorporated into the supplementary material.

Country	inhabitants (2022)	MSW per capita (kg/inhab/day)	MSW per capita (t/in- hab/day)	MSW t/year	The country takes ad- vantage of % of	Recovery/Country
Argentina	45.808.747,00	1,15	52.680,06	19.228.221,55	0,06	1.153.693,29
Brasil	213.993.441,00	1,40	299.590,82	109.350.648,35	0,04	4.374.025,93
Chile	19.212.362,00	1,30	24.976,07	9.116.265,77	0,10	911.626,58
Colombia	51.600.000,00	0,75	38.700,00	14.125.500,00	0,17	2.401.335,00
Costa Rica	5.180.000,00	1,50	7.770,00	2.836.050,00	0,04	113.442,00
Ecuador	17.888.474,00	0,58	10.375,31	3.786.989,95	0,74	2.802.372,56
México	130.120.000,00	1,00	130.120,00	47.493.800,00	0,10	4.559.404,80
Perú	33.396.000,00	0,81	27.050,76	9.873.527,40	0,02	187.597,02

Source

<https://www.argentina.gob.ar/ambiente/control/rsu>

<https://www.gov.br/mma/pt-br>

<https://agenciabrasil.ebc.com.br/es/geral/noticia/2022-06/la-tasa-de-reciclaje-en-brasil-es-solo-del-4-dice-abrelpe>

https://colaboracion.dnp.gov.co/CDT/Vivienda%20Agua%20y%20Desarrollo%20Urbano/Guia_Residuos%20Solidos_Digital.pdf

<https://minae.go.cr/>

<https://bogota.gov.co/yo-participo/blogs/basura-en-bogota-una-responsabilidad-de-todos-los-ciudadanos>

<https://www.ambiente.gob.ec/programa-pngids-ecuador/>

https://apps1.semarnat.gob.mx:8443/dgeia/informe_resumen14/07_residuos/7_1_1.html

https://www.senado.gob.mx/64/gaceta_comision_permanente/documento/98295

<https://www.minam.gob.pe/gestion-de-residuos-solidos/nueva-ley-de-residuos-solidos/>

<https://sinia.minam.gob.pe/informacion/tematicas?tematica=08>

Table S4. Waste Pickers Waste pickers in the selected countries and waste generation per capita in kg/day

Country	Recycling rate	Waste Pickers	Per capita generation kg/day
Argentina	Recycling statistics in Argentina are disparate, mainly because there is no uniformity at the national level in terms of waste treatment. According to UN figures, the amount of waste recycled in the country is only 6%, similar to other countries in the region.	150.000	1,15
Brasil	The recycling rate in Brazil is only 4%. The country produces 27.7 million tons of reusable materials per year.	800.000	1,40
Chile	<p>According to the Ministry of the Environment, recycling in Chile is 5% of tires, 50% of oils and lubricants, 7% of batteries, less than 2% of large and small household appliances, 17% of computer equipment, and 80% of paper and cardboard, among others.</p> <p>Chile generates almost 17 million tons of solid waste annually, of which 6.5 million tons are household waste, one of the highest rates in Latin America. While no country exceeds 15% of recycled material in the region, this figure is barely 10% in Chile.</p> <p>In 2019, 7,860,784 tons of municipal waste were generated, with a projected population of 19,107,216 inhabitants, which means an average of 1.13 kilos per day per inhabitant.</p>	60.000	1,30
Colombia	<p>Colombia collects and disposes of 26,975 tons of domestic solid waste daily in landfills. Bogota is the city that generates 6,300 tons/day of waste, and the department of Antioquia (3,260 tons/day), Valle del Cauca (3,072 tons/day), and Atlántico (1,907 tons/day).</p> <p>Recycling is an important issue, but much remains to make. Colombia only recycles 17% of the 12 million tons of solid waste annually, representing 31,000 tons per day and an average of 1.8% of the total urban solid waste generated.</p>	125.000	1,80
Costa Rica	Costa Rica produces around 4,000 tons of waste every day. It generates 0.8 kilograms of waste per inhabitant per day. Costa Rica, the national movement was formed in 2013, composed of 100 of the about 250 waste pickers who work in the dumps that still operate in different parts of the country. Ley Para La Gestión Integral de Residuos, Ley 8839/2010 or “Law”	250	0.80
Ecuador	INEC, 96% of garbage is hidden, and only 4% is recycled. Of what is hidden, 66.5% is organic, and the remaining 33.5% corresponds to inorganic waste, most of which can be properly sorted and recycled. Nevertheless, it is thrown away.	20.000	0,58
México	Urban and industrial solid waste has an 80% utilization window. According to SEMARNAT, 102,895 tons are daily, of which collection is 83.93%. Of this percentage, 78.54% goes to landfills, and only 9.63% is recycled. In Mexico, 31,300,000 people aged 15 and over are in informal employment, representing 56.2% of the employed population.	31.3 million	1.00
Perú	On average, more than 18,000 tons of waste are generated daily in Peru, and 15% is recycled. In addition, an estimated 100,000 people make a living from informal waste collection, working in dangerous and unhealthy conditions.	100.000	0.61

REFERENCIAS.

Ministerio de Ambiente y Desarrollo Sustentable (MAyDS)<http://servicios.infoleg.gob.ar/infolegInternet/anexos/95000-99999/98327/norma.htm>
https://www.andi.com.co/Uploads/Nueva%20Pol%C3%ADtica_Ambiental_RESPEL%202022-2030.pdf
<https://sgc.dadep.gov.co/7/3/127-PPPGR-04.pdf>

<https://medioambiente.uexternado.edu.co/codigo-de-colores-para-la-separacion-de-residuos-solidos-en-el-pais-posibles-inquietudes-sobre-la-medida/>

<https://www.ambiente.gob.ec/programa-pngids-ecuador/>

<https://cuentame.inegi.org.mx/territorio/ambiente/basura.aspx?tema=T>

<https://minae.go.cr/>

<https://mma.gob.cl/>

<https://sinia.minam.gob.pe/sites/default/files/archivos/public/docs/2093.pdf>

<https://www.gob.pe/institucion/minam/noticias/487809-alrededor-de-93-mil-toneladas-de-residuos-solidos-fueron-valorizados-en-el-2020-a-nivel-nacional>

<https://sinia.minam.gob.pe/novedades/peru-solo-se-recicla-19-total-residuos-solidos-reaprovechables>

<https://renarec.com/quienes-somos/>

<https://compuempresa.com/info/asociacion-de-recicladores-juan-pablo-ii-los-olivos-20544969740>

http://municipal.cegesti.org/manuales/download_guia_reciclaje_inclusivo_informales/guia_reciclaje_inclusivo.pdf