Variables with Incidence in the Generation of Microdumps in Chile, Comparative Study between Las Condes and El Bosque Municipalities

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https://doi.org/10.29227/IM-2025-02-02-081

Submission date: *2025-04-07* | Review date: *2025-08-21*

Abstract

The existence of microdumps is an important problem worldwide and Chile is not an exception to this reality. There is a total of approximately 3,492 illegal final disposal sites for waste at the national level, classified as microdumps (sites under 1 Ha.). In Chile illegal dumps are on the rise and the Metropolitan Region (RM) is the city with the highest percentage. This study analyses the most important variables that explain this phenomenon comparing two municipalities of the RM, Las Condes and El Bosque, that differ, especially in socioeconomic status. The IPS (Indice de Prioridad Social/Social Priority Index) evaluates municipalities every year using three indicators: income, education and health. Las Condes is one of the municipalities with the best socioeconomic situation in the RM, at position N°51 of 52, in the category of "no social priority", unlike the municipality of El Bosque, at position N°8 of the ranking, in the category of "mid to high social priority" according to IPS 2022 and in 2021 the same municipality reached position N°7 entering the category of "high social priority". The Municipality of Las Condes has 10 microdumps with a density of 0.227/Km2 and has 6.66 m$/inhabitant for solid waste management, while the municipality of El Bosque has 48 microdumps with a density of 3.71/Km2, with most of these located in areas of greater social vulnerability and it only has 2.80 m$/inhabitant (42%) to perform the same function. The study concludes that the factors with the highest incidence in the generation of microdumps include social vulnerability of inhabitants, municipal resources for solid waste management, and the level of employment and education of the municipality's inhabitants.

Keywords: *micro dump, illegal dumping, flytipping*

1. Introduction

Over the years population growth entails an alarming conundrum, the generation of waste and its treatment [1]. Worldwide, the projections estimate that by 2050 will be generated up to 3.4 billion tons of municipal solid waste [1]. Large quantities of solid waste are produced from everyday activities of residential, commercial and industrial sectors [2]. These wastes find their way into landfills, which are long-term storage facilities with no or little treatment, especially in developing countries [3].

Regardless of the level of treatment mandated by different governments, micro dumping is always generated. These are also referred to as fly-tipping, illegal dumping, or the unlawful disposal of waste, generating a complex problem for governments throughout the world. It poses hazards for the wellbeing of both human health and the ecosystem alike [4, 5].

Illegal solid-waste dumping, a sustainability challenge [6,7], particularly in developing country cities and towns [7]. Illegal solid-waste dumping has serious negative social, economic and environmental impacts on residents, especially in poor neighborhoods [7–9].

According to the latest CENSUS of population and housing carried out in Chile during the year 2017, Chilean population reached a total of 17,574,003 people, of which 7,112,808 reside in the Metropolitan Region [10] It´s capital, the City of Santiago, has 5,250,565 inhabitants spread out in 52 municipalities with a total surface of 2,109.7 km^2. The economic growth registered in Chile during the last decade has led to an increment of garbage generation by inhabitant, that during 2018 reached 19.6 million tons nationwide, of which 45% are of municipal origin [11].

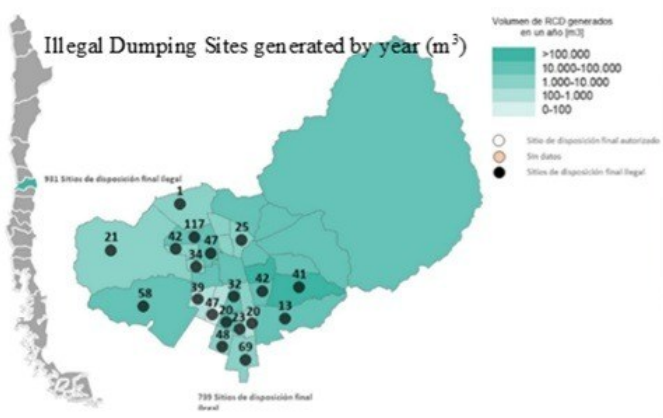

Fig 1a Illegal Dumpling Sites generated by year (m3) MR.

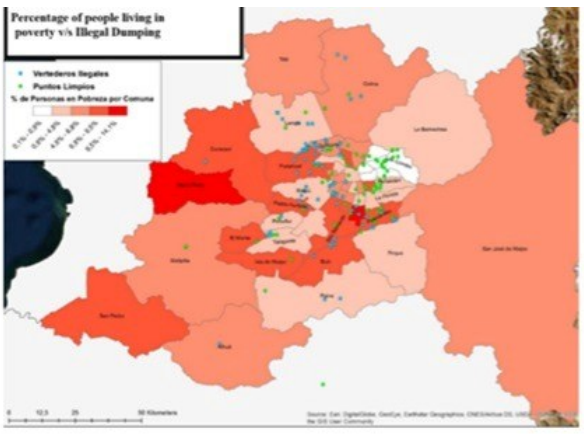

Fig 1.b % people living in poverty v/s Illegal Dumping Sites

Chile generates around 7 million tons of domestic waste per year, equivalent to close to 1.27 kilos of waste per person per day. 45.7% of municipal waste generation corresponds to the Metropolitan Region, which concentrates 41.4% of the country's population [11]. Around 80,51% of waste ends up in sanitary landfills, 13.63 is sent to dumps and the rest to other destinies of final disposition [12].

Currently there are 3,735 sites of illegal final disposition of waste, mainly solid domestic waste. Of these, 34.65% (3,492 sites) are micro dumps (sites 1 ha.) that cover 1,444.08 hectares, and 2.41% (243 sites) are illegal dumps (sites over 1 ha.) of the remaining 62,95% there is no information regarding surface. This problem not only damages the ecosystem and impedes the valorization of waste, it also has an impact in the health of nearby populations. [13].

According to law, the task of collecting, transporting and final disposition of solid domestic waste is up to municipalities. This is done via contracts with private companies or internally arranged, taking over recollection with disposition in sanitary landfills or controlled dump sites [14]. However, there is no integral management of waste and, generally, they are eliminated without taking into account strategies to encourage the prevention of its generation or its potential valorization [15].

Illegal solid waste dumps and micro dumps are mostly located in municipalities with low levels of income and high vulnerability indexes, with a negative impact in municipal economic resources, as they have to allocate resources in equipment and personnel to classify, extract, transport and eliminate the waste illegally disposed of in public spaces, to the detriment of other activities that are essential for the community [16, 17].

2. Methodology

With the objective of establishing what parameters have a higher impact in the emergence of micro dumps, the Metropolitan Region was taken as the study area, as it houses 42% of the country's population and the largest number of micro dumps [12].Within the Region the municipalities analyzed were Las Condes and El Bosque, both belonging to the capital Santiago, as they feature a large disparity in the economic variable.

The study used as a base the Index of Social Priority/Índice de Prioridad Social (IPS) a composite indicator that includes relevant aspects of social municipal development, including measurements in: income, education and health [18]. It's a synthetic index whose numeric value makes it possible to gauge the level of relative development reached by the population of a municipality. Thus, the IPS value obtained by each municipality can only be understood in relation to the values of said index in the remaining municipalities. The ranking includes the 52 municipalities of the Metropolitan Region, and classifies them in: High Social Priority/Prioridad Social Alta (PSA), Medium High Social Priority/Prioridad Social Media Alta (PSMA), Medium Low Social Priority/Prioridad Social Media Baja (PSMB), Low Social Priority/Prioridad Social Baja (PSB), Without Social Priority/Sin Prioridad Social (SPS). According to this Ranking the municipality of El Bosque is located at number 8 (PSMA) and the municipality of Las Condes at number 51 (SPS). [19].

The presence of micro dumps in both municipalities brings forward questions about the underlaying causes of this disparity, so an analysis and comparison were carried out for both municipalities on their surface, green areas, waste management, solid domestic waste management plans, municipal budget allocated to waste management, and number and location of micro dumps. Furthermore, an analysis was made on each municipality's population, composition, degree of vulnerability, socioeconomic, educational and health levels, in order to infer what are the main variables that have a bearing in the emergence of micro dumps.

The city of Santiago, the nation's capital, is located in Chile's central zone and its population is a homogenous mix of natives and Spanish. According to the Census of Population and Housing of 2017, 2,185,792 persons in Chile identify as belonging to an indigenous or original peoples, equivalent to 12.8% of the country's total population located mainly in the north and center south. Lately an 8,8% of migrant population has been added, coming mainly from Latin-American countries [20,21]. Due to the cultural homogeneity of the zone under study, that variable was not added to the study.

The comparative analysis of these variables seeks to infer which are the main variables that have an impact on the emergence of micro dumps in the country and collaborate in the control of a problem that leads to severe problems with health and quality of life of the population, as well as the deterioration of the national environment.

3. Analysis

3.1. Municipal background

The Santiago Municipal Region, located in the center of the country, is divides in 52 municipalities, each headed by a mayor elected by popular vote and an accompanying council. They are charged with diverse tasks, from municipal cleaning and social, economic and cultural development plans to basic health services and primary and secondary education [14].

This study was carried out comparing two municipalities with great social, economic, transport, housing and other differences, where the inhabitants of the municipality of Las Condes have a better quality of life than the people that live in the municipality of El Bosque. Thus, the waste management, number of illegal dumps and the vulnerability indexes of their inhabitants were analyzed.

Municipality of El Bosque

The Municipality of El Bosque is located in the southern zone of the capital city, in the Metropolitan Region. It has a Surface of 14 [km^2] and a population, according to the 2017 census, of 162,505 inhabitants. The municipality has a total of 48 micro dumps, corresponding to a rate of 3,4 MD/Km^2 [22].

Regarding the socioeconomic conditions of the El Bosque municipality, 14.5 % of the population is below the poverty line. This rating exceeds regional and national ratings of 6.2% and10.4% respectively.

It has 115 educational establishments, including pre-school, elementary, high school and vocational school. Included in this total, 27% are free municipal schools and 73% paid private schools.

The El Bosque healthcare network is administered by the Municipality via the Direction of Municipal Healthcare and belongs to the Southern Metropolitan Healthcare Service. It has 12 healthcare centers.

The municipality has 180 public spaces considered green spaces, with a rate of 2.1 m2 per inhabitant, quite low in comparison to the 9 m2 prescribed by the WHO. There are 103 sports venues in the municipality.

Municipality of Las Condes

Las Condes is located in the Eastern zone of the city of Santiago, Metropolitan Region. It has a Surface area of 99 Km^2 and a population of 294,838 inhabitants. The municipality has a total of 10 micro dumps located in zones with high vulnerability ratings, corresponding to 0.23MD/Km^2 [23].

According to Casem survey data (9) the rate of multidimensional poverty in Las Condes reached 4,4% during 2022, while the rate of the Metropolitan Region is 17,1% and the country rate is 16,9%. The Las Condes healthcare network administered by the Municipality has 15 healthcare centers and is part of the Eastern Metropolitan Health Service. The municipality has 56 educational establishments including pre-school all the way to complete high school and 14 professional training institutes and universities. It has a total of 72 green spaces, including 11 (15.3%) with a surface in excess of 5,000 m^2 (Figueroa, 2009). In Las Condes, the surface of green spaces per inhabitant is 14.8 m^2.

3.2. Vulnerability background.

In order to analyze the vulnerability variable of the municipalities, the base line selected was the Social Priority Index/Índice de Prioridad Social (IPS) for the 52 municipalities of the Santiago Metropolitan Region. This index integrates social municipal development aspects, including the following dimensions: income, education and health, with a variation from 88,03 High Social Priority/Alta Prioridad Social (APS) to 3,84 No Social Priority/Sin Prioridad Socia (SPS). According to this Ranking, the municipality of El Bosque is located at Ranking 8 with a Medium High Social Priority Index/Índice de Prioridad Social Media Alta (PSMA) IPS (75,50) and the municipality of Las Condes at the Ranking 51 No Social Priority/Sin Prioridad Social (SPS). IPS (13,07). [18, 19].

Tab .1. Category of the municipalities Las Condes y El Bosque

Municipality	Ranking	Social Priority Index (IPS)	Category
El Bosque	8	75.50	PSMA
Las Condes	51	13.07	SPS

Socio Economic Variable: To analyze this variable, a comparison was carried out of the average income of the population, the percentage of the population below the poverty line, number of housing units, index of housing units with acceptable materials, housing deficit and index of people in housing units with critical overcrowding (over 5), medium (from 2,5 to 4,9) and with no overcrowding (below 2.4). (The **overcrowding index results from the** quotinent from the number of persons and the number of rooms used as bedrooms) [13]

Income Aspect

The income aspect was calculated taking the percentage of the municipal population that falls in the 40% lower income in the Socioeconomic Qualification/Calificación Socioeconómica (CSE) according to the Social Housing Registry/Registro Social de Hogares (RSH) calculated during October 2021 by the Ministry of Social Development and Family and the average taxable income of current workers affiliated to the Unemployment Insurance of the Unemployment Funds Administration (AFC), 2020. This index corresponds to people below the poverty line. [24]

The poverty rate is calculated from the number of incomes per household and the number of people, taking a basic basket into consideration.

Tab. 2. Poverty Rate per Municipality

Territorial Unit	Income		Poverty Rate
	Percentage of people below the 40% level	Average Income[a] (€)	%
EL Bosque	62.9 %	700	12.56
Las Condes	23.4%	1.940	2.79
Country	67.2%	830	6.5

a: 1 **€ = 1.000 chilean pesos $**

Other indexes used include the Rate of Poverty per Income/Tasa de Pobreza por Ingresos (TPI) and Multidimensional Poverty that is an index that measures the percentage of households in a country that suffer deprivation in three aspects (monetary poverty, education and basic infrastructure services) in order to obtain a more complete panorama on poverty. Also, persons lacking Basic Services/Servicios Básicos (SSB) of potable water, sewage and electricity and in overcrowding situation. (total % up to 2023)

Tab. 3. Comparison of the Magnitude of People's Poverty

Territorial Unit	Poverty Rate / Income (%)	Multidimensional Poverty (%)
El Bosque	6.2	17.5
Las Condes	0.9	4.4
Metropolitan Region	4.4	17.1
Country	6.5	16.9

Tab. 4. Comparison of people lacking basic services and in a state of overcrowding

Territorial Unit	People without basic services (%)	People in state of overcrouding (%)
El Bosque	6.0	9.3
Las Condes	3.0	3.5
Metropolitan Region	8.5	8.4
Country	13.6	8.5

Education Aspect

According to the 2017 census the population of school age of 5 to 19 years old in the municipality of Las Condes reaches 47,028 students with a total of 50 educational establishments including basic and high schools, while in El Bosque there are 60,013 persons of school age and 92 schools.

Educational efficiency was measured with the results of the SIMCE test [25]t aken by 2° year high school students medio (10 years of schooling) during 2022. This is a national test that is taken by all the country's students.

Another parameter taken into account were the results of the University Transition Test/Prueba de Transición Universitaria (PDT) 2022 that is applied nationwide to students that finished their high school and wish to apply to a university. The result obtained by

students in the PDT has an important effect on their possibilities of accessing higher learning, and their possibilities of entering the labor market and generating income in the future.

The results delivered by the Association of Municipalities of Chile to measure the quality of education aggregate the communes in 5 group, taking in account the SINCE and PDT test. Las Condes rated in Type 1: group with the best results in quality of education, In general, most of its student's study in private schools (64%), only 18% of its student's study in subsidized private schools, and 18% in municipal schools. The El Bosque is rated as Type 3: This group does not reach on average the minimum required by the Ministry of Education in any of the SIMCE tests analyzed, obtaining a low average in the PDT. 40% of students study in municipal schools, 57% in subsidized private schools, and only 2% in private schools. [26]

Tab. 5. Quality of Education

Territorial Unit	SIMCE 2022		University Transition Test PDT	QUALITY RANKING TYPE
	READING	MATHEMATICS		
El Bosque	240	252	477.6	3
Las Condes	270	313	606.9	1
Metropolitan Region	246	259	No information	-
Country	243	252	499	-

Health Aspect

This aspect considered 3 parameters for the 2017-2021 period: **Rate of years of life potentially lost per inhabitant/Tasa de años de vida potencialmente perdidos por habitante (TAVPP)**. This parameter adds up the number of years per inhabitant that are lost to premature death before 80 years, making it possible to identify the municipalities with the greater damage in health because it sums up a set of variables tales such as: access to emergency, primary and hospital care, the existence of sanitary infrastructure such as potable water, advancement of public health programs, among others. **Rate of specific fertility for women 15 to 19 years old/Tasa de fecundidad específica de mujeres entre 15 y 19 años (TEFA)** This indicator takes into account household vulnerability since these adolescents, generally unmarried, don't finish their school education, this way poverty is perpetuated and maintained. **Percentage of children under 6 years with malnutrition/Porcentaje niños menores de 6 años en situación de malnutrición (NEMN)**. Malnutrition was compounded by aggregating the categories of undernourishment, overweight and obesity. It should be noted that, as a country, Chile is the most obese nation in Latin America, and 20% of girls and 30% of boys have been declared obese. [18, 27]

Tab. 6. Comparison of the health dimension variable

Municipality	HEALTH		
	TAVPP	TEFA	NEMN
El Bosque	80.3	30.9	36.8
Las Condes	35.0	3.9	32.9

Analyzing all these variables with their different dimensions we can understand why the Municipality Las Condes is in the 51st ranking and El Bosque in the 8th Ranking of the 52 communes of the Metropolitan Region

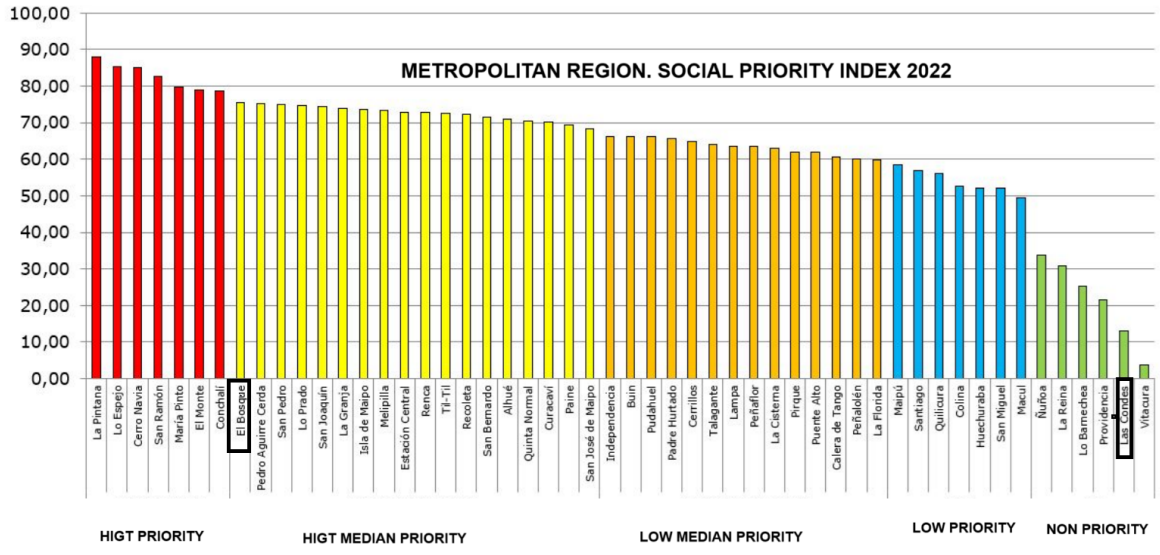

Fig. 2 Ranking of all communes of the Metropolitan Region

3.3 Compared Municipal Backgrounds

To analyze this variable, the economic background for household garbage management for both communes was compared, both total income and those destined for cleaning and ornate during 2023. [28] and the amount of money spent on cleaning per inhabitant was determined.

Tab. 7. Municipalities Incomes and Expenditures

Municipality	Las Condes	El Bosque
Total Municipal Income	269.328	71.515
Expenditures in cleaning and ornate	19.646	4.897
Expenditures in cleaning and ornate per inhabitant.	0.067	0.030

Values in Euros (€)

The number of micro dumps (MD) present in each municipality and its location regarding the socioeconomic level of its surroundings were also analyzed.

Tab. 8. Number of micro dumps and and its location regarding the socioeconomic level

Municipality	Number	Municipal Surface (Km^2)	MD/Km^2	Economic zoning
Las Condes	10	43,98	0,23	Medium – Low
El Bosque	48	14	3,40	Low

Fig. 3. Micro Dump in El Bosque

Fig. 4. Micro Dump in Las Condes

Other data analyzed were the Tons of Household Waste Generated/Toneladas de Residuos Domiciliarios Generados (TRS), Tons of Recycled Waste/Toneladas de Residuos Reciclados (TRR) Percentage of Recycled Waste/Porcentaje de Residuos Reciclados (RR%) and Percentage of Household Waste Disposed in Sanitary Landfills/Porcentaje de Residuos Domiciliarios Dispuestos en Rellenos Sanitarios (DFRS).

Tab. 9 Amount of Household waste generated and recycled

Municipality	Household Waste (Ton)	Recycled waste (Ton)	Percentage of Recycled Waste (%)	Percentage of Household Waste Disposed in Sanitary Landfills (%)
Las Condes	115.591	7.389	15.38	84.2
El Bosque	76.653	0	0	100

Comparing the tons of waste generated versus micro dumps, it can be observed that, even though the municipality of Las Condes produces more tons of waste than El Bosque, it has fewer micro dumps than El Bosque, therefore the tons of waste produced in the municipalities is not directly proportional to micro dumps [19]. The presence of fewer micro dumps in Las Condes could indicate a more efficient waste management in that municipality, with the conclusion that the investment made in each municipality in cleaning has an influence in management and in the micro dumps that are generated.

4. Conclusions

The comparative study of micro dumps of the municipalities of Las Condes and El Bosque has shown important findings that highlight the complexity of this problem in diverse urban contexts. While there are significant differences in terms of health, education, income and socioeconomic level between both municipalities, the presence of micro dumps reveals a surprising similitude: In the sectors that are affected in Las Condes, people have a level of income and education like the inhabitants of El Bosque (Medium

Bajo). This result challenges the traditional perception that solid waste management is only determined by economic factors. Despite the fact that Las Condes has more financial resources and a more developed municipal infrastructure, the existence of micro dumps in areas of social housing in that municipality underscores that this is a multidimensional problem.

The comparison between Las Condes and El Bosque also highlights the importance of taking into consideration socio economic factors in the understanding and approach to micro dumps. While the difference in financial resources can have an influence in the magnitude and distribution of micro dumps, the presence of this problem in vulnerable sectors of Las Condes suggests that other aspects, such as equitable access to public services and community participation, have a crucial role in its perpetuation. The identification of zones affected by micro dumps in Las Condes, particularly in areas of social housing, underscores the need for more inclusive public policies and intervention programs that queue tackle socio economic disparities and promote an integral approach to solid waste management. It is essential to recognize that the problem of micro dumps cannot be reduced only to economic considerations, but must be approached in a multi-factory manner, considering social, environmental, educational and governance factors.

Ultimately, this study highlights the importance of managing solid waste under principles of equity and community participation, recognizing the specific needs and realities of each urban community. By adopting a collaborative approach, you can move forward towards more effective and sustainable solutions that improve the quality of life of all inhabitants, regardless of their socio-economic level.

References

1. Hao, X.; Dong, L.; Liu, G.; Zhang, X. Polycentric governance in waste management: A mechanism analysis of actors' behavior evolution at the community level. Resour. Conserv. Recycl. 2023, 191, 106879.
2. Kaza, S.; Yao, L.C.; Bhada-Tata, P.; Van Woerden, F. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050; World Bank: Washington, DC, USA, 2018. Available online: http://hdl.handle.net/10986/30317.
3. Kebede, Y.S.; Alene, M.M.; Endalemaw, N.T. Urban landfill investigation for managing the negative impact of solid waste on environment using geospatial technique: A case study of Assosa town, Ethiopia. Environ. Chall. 2021, 4, 100103.
4. Lu, W. Big data analytics to identify illegal construction waste dumping: A Hong Kong study. Resour. Conserv. Recycl. 2019, 141, 264–272.
5. Niyobuhungiro, R.V.; Schenck, C.J. The dynamics of indiscriminate/illegal dumping of waste in Fisantekraal, Cape Town, South Africa. J. Environ. Manag. 2021, 293.
6. da Silva, C.L.; Weins, N.; Potinkara, M. Formalizing the informal? A perspective on informal waste management in the BRICS through the lens of institutional economics. Waste Manag. 2019, 99, 79–89.
7. Kharas, H. The Emerging Middle Class in Developing Countries; Working Paper No. 285; OECD Development Centre: Paris, France. Available online: https://www.oecd.org/dev/44457738.pdf.
8. Ferronato, N.; Torretta, V. Waste mismanagement in developing countries: A review of global issues. Int. J. Environ. Res. Public Health 2019, 16, 1060.
9. Ngalo, N.; Thondhlana, G. Illegal solid-waste dumping in a low-income neighbourhood in South Africa: Prevalence and perceptions. Int. J. Environ. Res. Public Health 2023, 20, 6750.
10. Instituto Nacional de Estadísticas Chile. Resultados del Censo de Población y Vivienda 2017.
11. SINIA - Ministerio del Medio Ambiente de Chile. Residuos. Sexto reporte del estado del medio ambiente. 2021. Available online: https://sinia.mma.gob.cl.
12. Font, E.V. Disposición final de residuos sólidos: Rellenos sanitarios, vertederos y basurales. Asesoría Técnica Parlamentaria. Biblioteca del Congreso Nacional de Chile, 2023.
13. Morales Soto, M. Diagnóstico de la localización de microbasurales en la Región Metropolitana. Nadir Rev. Electrón. Geogr. Austral 2016, 8(2).
14. Ministerio del Interior de la República de Chile; Subsecretaría de Desarrollo Regional y Administrativo. Ley 21534. Fija el texto refundido, coordinado y sistematizado de la Ley Nº 18.695, Orgánica Constitucional de Municipalidades. 2023.
15. Ministerio del Medio Ambiente de la República de Chile. Ley 20920. Marco para la gestión de residuos, responsabilidad extendida del productor y fomento al reciclaje. 2016.
16. R-R-Cities; Ocean Conservancy (OC); The Circulate Initiative (TCI); Kyklos Acción Circular; Do!Smart Cities. Región Metropolitana de Santiago, Chile: Perfil de la Gestión de Residuos. Resilient Cities Network, 2024.
17. Ossio, F.; Faúndez, J. Diagnóstico nacional de sitios de disposición ilegal de residuos. 2021. Available online: https://www.researchgate.net/publication/348443724.
18. Ministerio de Desarrollo Social y Familia. Región Metropolitana. Índice de prioridad social de comunas. 2022.
19. Ministerio de Desarrollo Social y Familia. SEREMI Región Metropolitana de Santiago. Indicadores sociales encuesta CASEN. 2023.
20. Ministerio del Interior y Prevención del Delito. Resolución exenta 1053: Establece clasificación de comunas de acuerdo al índice de vulnerabilidad socio delictual y determina montos de financiamiento de proyectos de prevención de delitos. 2013.
21. Ministerio del Interior y Seguridad Pública. Encuesta Casen: Población Migrante en Chile. 2022.
22. Ilustre Municipalidad El Bosque. Plan de desarrollo municipal PLADEM 2017–2024.
23. Ilustre Municipalidad de Las Condes. Plan de desarrollo municipal PLADEM 2022.
24. Ministerio de Desarrollo Social y Familia. Registro social de hogares. 2023.
25. Agencia de Calidad de la Educación, Gobierno de Chile. Indicadores de desarrollo personal y social y pruebas SIMCE. 2022.
26. Asociación de Municipalidades de Chile. Estudio de la calidad de la educación en Chile. 2021.
27. Estadísticas Territoriales. Biblioteca del Congreso Nacional. Estadísticas de Salud. 2023.
28. Portal transparencia [Online] Available at: https://www.portaltransparencia.cl/PortalPdT/.