



Challenges and opportunities for sustainable urbanization and local environmental management in 88 cities from the state of Minas Gerais, Brazil

Desafios e oportunidades da urbanização sustentável e da gestão ambiental municipal em 88 cidades do estado de Minas Gerais, Brasil

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ABSTRACT: This study aims at increasing knowledge about the challenges, opportunities and contexts of municipal environmental management in the state of Minas Gerais, Brazil. Through an online questionnaire sent to contacts from 760 municipal environmental agencies, 88 valid answers were obtained. The data were analyzed using descriptive and inferential statistics. Among the results achieved, the following stand out: (i) the challenges and opportunities related to the management of urban solid waste are central and feedback negatively due the lack of personnel, resources and projects; (ii) there is a favorable scenario for ecological restoration and circular economy in the municipalities that is not carried out as a consequence of low institutional capacity; (iii) municipal conservation units (CUs) were more frequent than federal and state ones, which is positive; however, it alerts to the underreporting of municipal CUs in the national registry and to the need for research and efforts that integrate municipalities into the context of specially protected territories; (iv) 68% of the sampled municipalities received the 'ICMS Ecológico' tax benefit, which must be related to the observed frequency of municipal CUs; (v) 60% of the municipalities have some type of environmental regulation of their own regardless of the population size and environmental licensing for projects with a local impact; (vi) intersectionality is practiced between the municipal and state environmental bodies, which may be related to standard procedures, such as the Ecological Tax (ICMS); (vii) the municipal environmental councils were appointed as the main management instrument, referring to the importance of

democracy for environmental management; (viii) one third of the sampled managers do not fully understand the context of the SDGs (Sustainable Development Goals); and (ix) partnerships between municipal environmental management agencies and universities that are located in the territories has a potential to be promoted. It is recommended that research, innovation and entrepreneurship institutions pay attention to the socioenvironmental opportunities present in inland municipalities.

Keywords: municipal environmental management; environmental public policies; sustainability; sustainable urbanization.

RESUMO: Este estudo buscou ampliar o conhecimento sobre os desafios, as oportunidades e os contextos da gestão ambiental municipal em Minas Gerais. Através de um questionário on-line enviado a contatos de 760 municípios, obteve-se 88 respostas válidas. Os dados foram analisados através do uso de estatística descritiva e inferencial. Dentre os resultados alcançados destacam-se: (i) os desafios e oportunidades relacionados à gestão dos resíduos sólidos urbanos são centrais e se retroalimentam negativamente pela falta de pessoal, de recursos e de projetos; (ii) há um cenário favorável à restauração ecológica e à economia circular nos municípios, que não é realizado devido à baixa capacidade institucional; (iii) as unidades de conservação (UCs) municipais foram mais frequentes que as UCs federais e as estaduais, um dado positivo, mas que alerta para a subnotificação de UCs municipais no cadastro nacional e para a necessidade de pesquisas e esforços que integrem os municípios ao contexto dos territórios especialmente protegidos; (iv) 68% dos municípios amostrados recebiam, no momento da amostragem entre ago-2018 e ago-2019, ICMS Ecológico, o que deve estar relacionado à frequência observada de UCs nos municípios; (v) 60% dos municípios têm algum tipo de norma ambiental própria e isto independe do tamanho populacional e da realização de licenciamento ambiental de empreendimentos de impacto local; (vi) a intersetorialidade é praticada entre as instâncias ambientais municipais e as estaduais, o que pode estar relacionado a procedimentos padrão, como o do ICMS Ecológico; (vii) os conselhos municipais de meio ambiente foram apontados como o principal instrumento de gestão, remetendo à importância da democracia para a gestão ambiental; (viii) um terço dos gestores amostrados não compreendem bem o contexto dos ODS (Objetivos do Desenvolvimento Sustentável); (ix) parcerias entre a gestão ambiental municipal e as universidades presentes nos territórios são um potencial a ser impulsionado. Recomenda-se que as instituições de pesquisa, inovação e empreendedorismo tenham atenção e um olhar mais direcionado para as oportunidades socioambientais presentes nos municípios menores e interiores.

Palavras-chave: gestão ambiental municipal; políticas públicas ambientais; sustentabilidade; urbanização sustentável.

1. Introduction

According to the World Health Organization (WHO), 55% of the world population is concentrated in cities. 80% of the Brazilian population lives in urban areas. It is foreseen that these rates will rise to 70% and 90% by 2050 for the world and Brazilian population, respectively. For most of the people living in urban areas, good cities guarantee

good life. It is at the level of the municipalities that public policies become more noticeable in quality of life, in citizens' well-being and in the reduction of inequalities (UN-Habitat, 2020).

At the global level, local governments have assumed a central role in implementing an agenda targeted at sustainability. Sustainable urbanization, as guided by UN-Habitat in the “World Cities Report 2020 – The Value of Sustainable Urbanization”,

has the potential to direct efforts towards the Decade of Action and the implementation of the 2030 Agenda and its SDGs (Sustainable Development Goals), considering recovery from the COVID-19 pandemic in this context (UN, 2015; UN-Habitat, 2020; RAPS, 2020; Santos, 2021). With its 17 SDGs and 169 targets, the 2030 Agenda is a multilateral global action plan – committed to the paradigm shift of sustainability – that guides the actions of the international community in its various fora in the coming years (UN, 2015).

SDG 11 – Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable – is a prism of all other SDGs in the territories, evidencing the role of cities and sustainable urbanization for humanity to find answers to the systemic crises of the Anthropocene (Pickett et al., 2013; UN-Habitat 2017; UN-Habitat & Colab, 2019; UN-Habitat 2020; Latour, 2020).

However, sustainable urbanization processes are still a distant and Utopian reality for many countries and regions, especially in the Global South, where cities commonly reflect negligence and historical neglect of the environment and are spaces marked by inequality and segregation of the population. Social inequality is an attribute that is characteristic of cities, mainly sustained by structural racism and classism (Schell et al.; 2020; Oxfam, 2021a). In this context, in many regions, even from Brazil, it was cruelly exposed and worsened by the COVID-19 pandemic (Bruce et al., 2020; Oxfam, 2021b; Tavares & Betti, 2021).

Systemic inequalities exert profound impacts on global ecological crises, as well as on losses in terms of biodiversity and ecosystem services (Anguelovski et al., 2016; Schell et al, 2020). The decisive role of local governments in worsening

such crises and inequalities or in contributing to sustainability is related to the municipalities' institutional and public management ability.

Municipal environmental management – as provided for in the Federal Constitution (Brazil, 1988), the Environmental National Policy (Law No. 9,638/1981) and so many other national legal and policy regulations – is a potential driving force for sustainable urbanization and the successful implementation of global agendas, such as the SDGs and the Paris Agreement.

Seeking to contribute to the many urban challenges, various technological innovations have been developed and improved in several cities. As data on cities, municipal services and citizens become more transparent and open, sustainable, democratic, inclusive, participatory and evidence-based urbanization can also be improved (RAPS, 2017; Morozov & Bria, 2019; UN-Habitat, 2020).

The challenges and opportunities inherent to sustainable urbanization in Brazil are many and complex. Several mechanisms and instruments provided for in the Brazilian legislation are in favor of that – although some are underutilized, such as the Strategic Environmental Assessment (Sánchez, 2017). The global approaches and trends that highlight local governance turn to SDG 11 as an enhancing agent of the other SDGs, as well as of the 2030 Agenda. This context marked by opportunities, challenges, mechanisms, instruments, approaches and trends inherent to sustainable urbanization is represented by the conceptual model shown in Figure 1.

For the potential of sustainable urbanization to be realized, considering the various urban and territorial contexts, it becomes necessary to understand how municipal environmental management has

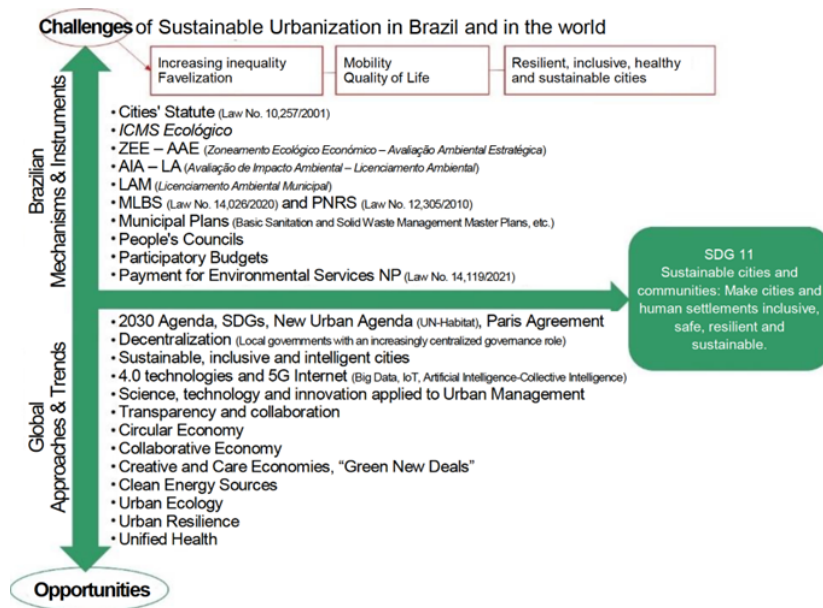


FIGURE 1 – Conceptual model of the sustainable urbanization challenges and opportunities, highlighting some mechanisms and legal instruments foreseen in Brazil and some global approaches and trends that contribute to local governments capable of achieving SDG 11 – Sustainable cities and communities. MLSB – Marco Legal do Saneamento Básico (Basic Sanitation Legal Framework); PNRS – Política Nacional de Resíduos Sólidos (Solid Waste National Policy); NP – National Policy.

SOURCE: Prepared by the authors.

been positioning itself before global agendas and using the framework of available policies, instruments, programs and strategies.

Seeking to contribute to sustainable urbanization, this study was developed with the objective of expanding knowledge about the conditions of local environmental management and the implementation of public policies in the municipalities from the state of Minas Gerais. The results obtained grounded the formulation of some proposals and recommendations for local environmental management targeted at sustainability.

2. Development and methodological

approaches

Minas Gerais is the state with the most municipalities in Brazil: 853. Of this total, 760 municipalities were contacted between August 2018 and August 2019.

The survey corresponding to the contacts of the environmental public managers from the Minas Gerais municipalities was through the City Halls' social networks and portals. The Minas Gerais Environment and Sustainable Development (State Department (*Secretaria de Estado de Meio Ambiente e Desenvolvimento Sustentável*, SEMAD) and the National Association of Municipal Environ-

mental Agencies (*Associação Nacional de Órgãos Municipais de Meio Ambiente*, ANAMMA) also contributed to surveying these contacts.

Most of the contacts with the local public agents was via email and, eventually, through a messaging app. Those who saw the contact but did not answer the questionnaire were sent a reminder to do so. The addressees who did not open the email message received it again. The email and contact message text included the study presentation and an invitation to take part in it, in addition to the Free and Informed consent Form and the link to the electronic research questionnaire. As a strategy to boost the number of answers, a scholarship for the “Collaborative Public Management” course, offered by Colab.re, a startup company that motivates citizens' leading role in the search for smarter and sustainable cities, was drawn in July 2019. All the respondents were sent a message thanking them for their collaboration.

The sampling questionnaire consisted of 44 questions, most of them closed. Pilot questionnaires were applied to two local Environment Managers, collaborators and considered in the research. The questionnaire was planned in order to find out the following:

- (a) The profile of the actors and municipal bodies involved;
- (b) The socioenvironmental challenges and opportunities experienced in the sampled municipalities;
- (c) The context of environmental management and public policies regarding sustainability in the Minas Gerais municipalities; and

- (d) Universities and research and technology institutions in the local environmental management context.

The data obtained were worked on in spreadsheets, analyzed by means of descriptive statistics, and presented in graphs and frequency distribution tables. Inferential statistics and the chi-square test (X^2) were used to verify whether the presence of environmental laws specific to each municipality were related to population size and to the fact that the municipality assumed responsibility for environmental licensing of local impact projects.

The population sizes of the sampled municipalities were obtained in consultation with the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística*, IBGE) and classified into four categories: up to 20,000, from 20,000 to 50,000, from 50,000 to 100,000 and more than 100,000 inhabitants. Verification of whether the sampled municipalities assumed the local environmental licensing (*Licenciamento Ambiental Municipal*, LAM), as well as the date and mode (consortium, individual or agreement) of those that did so, was made through Minas Gerais Environment and Sustainable Development Department (SEMAD – MG) website.

3. Results and discussion

Eighty-eight (88) municipalities returned the sampling questionnaire answered, which represents 10.32% of the municipalities in the state of Minas Gerais (853) and 11.58% of the 760 municipalities that were sought to contact in the sampling effort of this study. Figure 2 presents the spatial distribution

of the sampled municipalities in the various study regions.

Among the 88 municipalities sampled, 67% have populations of less than 20,000 inhabitants, of which 38% have less than 10,000 and 16%, less than 5,000. Nearly 22% are inhabited by 20,000 to 50,000 individuals and 7% have between 50,000 and 100,000 inhabitants. Only 5% of the cities sampled have more than 100,000 inhabitants. This proportion is compatible with the demographic density observed in Minas Gerais, where nearly 78% of the 853 municipalities have populations of less than 20,000 inhabitants (IBGE, 2018), indicating that, although small, the sample obtained in this study is representative of reality.

3.1. The profile of the actors and municipal

bodies involved

More than half of the sampling questionnaires were answered by municipal departments (52%), 24% by municipal employees in the position of head or director of the environment sector or division and 20% by City Hall technicians. Among the respondents, there was also a Mayor, a Deputy Mayor and a Cabinet Counselor, corresponding to 1% each.

Of the 88 respondents, 75 (85%) stated having Higher Education. Of those, 41% have some specialization and 9% are MScs. Nearly 14% of the respondents have High School or Technical levels and 1% had only attended Elementary School. Although most of these actors have Higher Education, only 57% have some type of training in the environmental area.

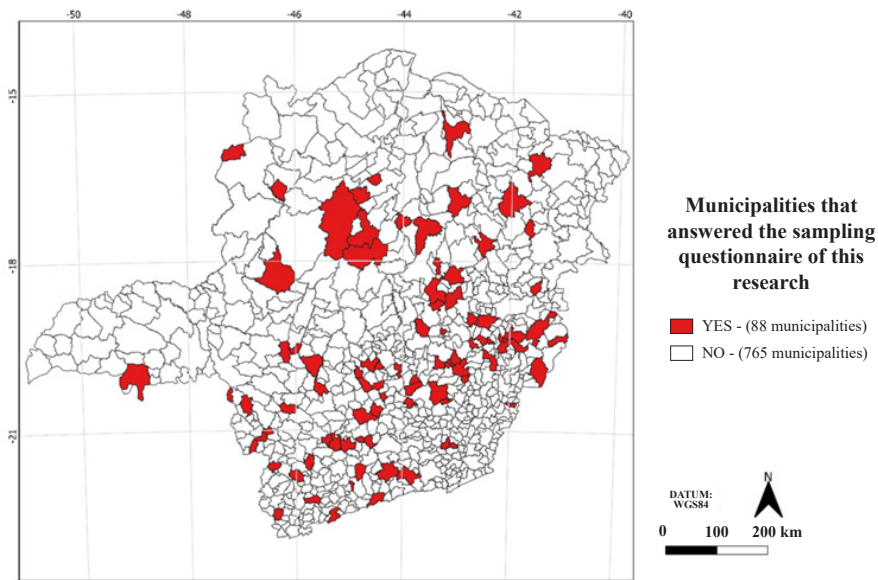


FIGURE 2 – State of Minas Gerais, with the sampled municipalities highlighted in red.

SOURCE: Prepared by the authors.

It was noticed that, usually, the environment sphere is shared with agriculture, livestock and economic development. Less frequently, the Environment Department proved to be shared with Tourism, Rural Development, Leisure and Culture. Only 30% of the sampled municipalities had a local department exclusively devoted to the environment or to the environment and sustainable development. Therefore, most of the secretaries who answered the questionnaire were devoted to joint spheres, in which the environment was frequently associated with subjects matters that are distant or little synergistic, only aiming at economic growth strategies.

According to the respondents, disclosing and visibility of the work developed is mainly through local social networks (83%), radios (47%) and newspapers (37%). Almost half (49%) of the interviewees stated using these means frequently.

3.2. The socioenvironmental challenges and opportunities experienced in the sampled municipalities

The main socioenvironmental challenge experienced at the local level in the sampled municipalities was the “increase in the production of urban solid waste” (70%). This fact indicates the extent to which waste management is a core element of local environmental management. Other frequent socioenvironmental challenges were the following: “water pollution” (62%), “native vegetation loss” (59%), “water crisis” (59%) and “soil erosion” (56%) (Figure 3).

“Water pollution”, “native vegetation loss”, “water crisis” and “soil erosion” are related to the fact that agriculture and livestock are the predomi-

nant economic activities in the sampled municipalities. When practiced extensively and dependent on agrochemicals, these activities lead to fragmentation and loss of habitats, contamination and eutrophication of waters and loss of soil quality, compromising environmental and human health (Karesh *et al.*, 2012; Marques-Filho, 2018; Johnson *et al.*, 2020). These challenges also result from the situation of the permanent preservation areas (PPAs) of the sampled municipalities, which according to the respondents, are threatened (64%) or nonexistent (17%) in the territories. Only 30% of the respondents stated that the PPAs were preserved or undergoing restoration procedures (26%).

The native vegetation cover plays a central role in regulation of the hydrological cycles and in water safety. In Brazil, it is even related to safe energy, as most of the electricity consumed in the country comes from hydroelectric plants. Therefore, it is urgent that ecological restoration gains incentive and stimulation, both at the local, territorial and municipal levels, as well as in state and national public policies and in the practices of corporations, companies, social organizations and citizens. Especially the Atlantic Forest biome, which occupies nearly 40% of the state of Minas Gerais (IEF, 2020), is found in the country with the largest and best opportunities for ecological forest restoration worldwide, considering economic return and viability of the reforestation processes (Brançalion *et al.*, 2019; Caldeira *et al.*, 2020).

The opportunities related to the restoration of ecosystems are in line with some of the main opportunities pointed out in the answers given to this study, namely: “agroforests and organic agriculture” (66%), “ecotourism” (58%), “traditional knowledge and practices” (52%), “payments for

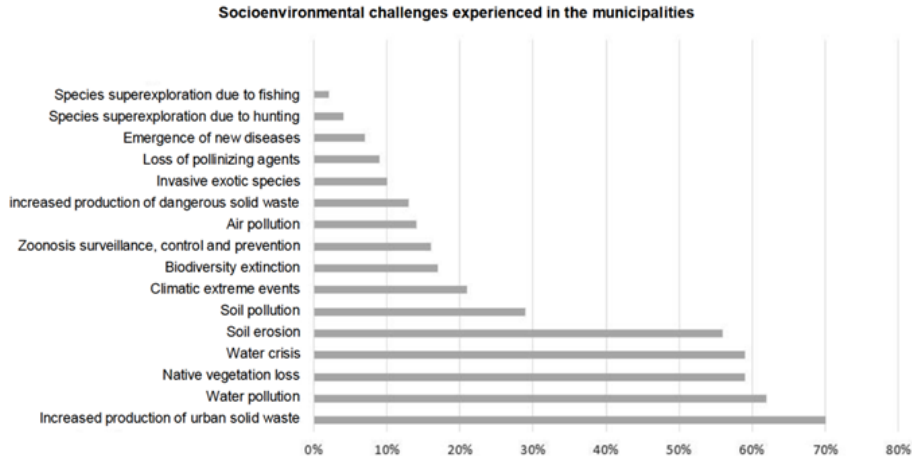


FIGURE 3 – Global environmental challenges experienced in the 88 Minas Gerais municipalities sampled, according to the frequency of answers given by the study respondents.

SOURCE: Prepared by the authors.

environmental services” (47%) and “sustainable forest management” (35%) (Figure 4).

When it comes to opportunities related to ecological restoration in Minas Gerais, it is worth noting that the environmental regularization program (*Programa de Regularização Ambiental*, PRA) – provided for by the native vegetation protection law known as the new Forest Code, Federal Law No. 12,651/2012 (Brazil, 2012) – was regulated in the state by Decree No. 48,127 of January 2021 (Minas Gerais, 2021). Together with the rural environmental registry (*Cadastro Ambiental Rural*, CAR) and environmental reserve quotas (*Cotas de Reserva Ambiental*, CRAs), the PRA comprises a triad of mechanisms capable of enabling a forest money market and boosting ecological restoration, while bringing together in a single platform all the data on native vegetation cover in the country, monitoring and managing environmental liabilities, especially on private properties. However, this potential has

been postponed, neglected and reduced by the lack of political will to implement and enable it more effectively (Imaflora, 2021; *Observatório do Código Florestal*, 2021).

“Urban Solid Waste (USW) recycling, reuse and management” was the main opportunity perceived by the respondents (68%) (Figure 4). This perception is in line with the challenge and untapped and disruptive potential of the circular economy and shared responsibility for the life cycle of products, one of the main mechanisms of the Solid Waste National Policy (*Política Nacional de Resíduos Sólidos*, PNRS) (Law No. 12,305/2010). The main tools of this policy are selective collection, reverse logistics and recycling (Brazil, 2010). In Minas Gerais, 36% of the municipalities still dispose of their waste in dumps (SEMAD, 2022a), sectoral reverse logistics agreements are incipient (FEAM, 2020) and selective collection has been stimulated through the *Bolsa Reciclagem* Program, established

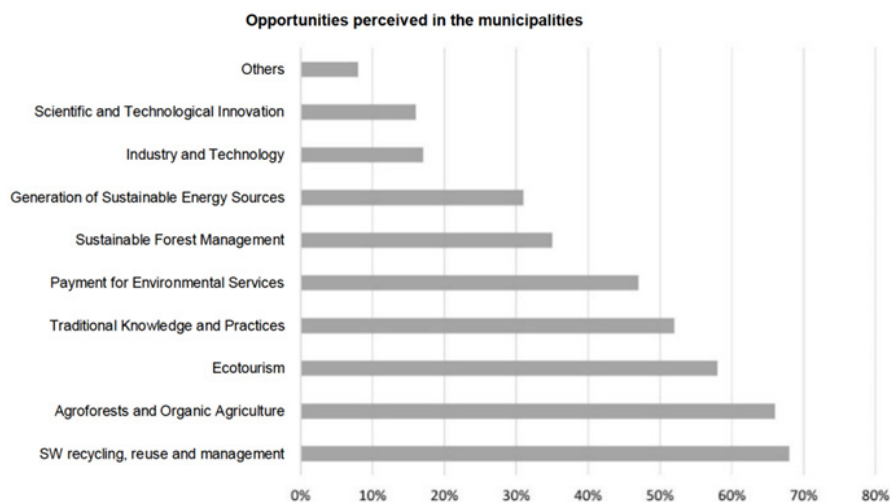


FIGURE 4 – Opportunities noticed in the Minas Gerais municipalities sampled, according to the frequency of answers given by the respondents to the sampling questionnaire on environmental management. SW – Solid Waste.

SOURCE: Prepared by the authors.

since 2011, which has 159 registered associations and cooperatives, bringing together nearly 2,400 people (SEMAD, 2022b).

The opportunities identified in “ecotourism”, “traditional knowledge and practices” and “payment for environmental services” (Figure 4) can be related to the fact that 60% of the sampled municipalities have some type of Conservation Units (CUs) (Brazil, 2000) (Figure 5a). According to the respondents, most of the CUs found in their territories are municipal (34%), followed by state CUs (23%), Private Natural Heritage Reserves (*Reservas Particulares do Patrimônio Natural*, RPPNs) (19%) and federal CUs (8%) (Figure 5b). The presence of these specially protected areas contributes to biodiversity conservation, health and sustainability, as they provide fundamental

ecosystem services and contribute to the mitigation of ecological crises (CI-Brazil, 2018; IPBES, 2019).

The fact that the local CUs are more common than their state and federal counterparts in the sampled municipalities indicates a positive aspect, although it deserves attention. This result is opposite to what is observed in the National Registry of Conservation Units (*Cadastro Nacional de Unidades de Conservação*, CNUC) of the Ministry of the Environment (*Ministério do Meio Ambiente*, MMA), in which municipal CUs only represent 16% of the total CUs in the country (Figure 6).

The comparison between the percentage of CYs in this study and the CNUC-MMA database (Figures 5 and 6) can be an indicator that the local CUs are undersampled in the national database. A survey by the *SOS Mata Atlântica* Foundation corroborates this, pointing out that only 23% of the

CUs from the Atlantic Forest biome are registered in CNUC-MMA (SOS Mata Atlântica, 2017). The technical report called “*Municipal Conservation Units of the Atlantic Forest*” also found that access to and availability of official information on municipal CUs by public agencies were only available for 28% of the areas surveyed and that it also of-

ferred incomplete and precarious data (SOS Mata Atlântica, 2017). The absence of these CUs in the single national register (CNUC-MMA) precludes the municipalities from receiving environmental compensation resources, causing harms that cities may oftentimes not be aware of, especially smaller ones and those with less qualified and structured

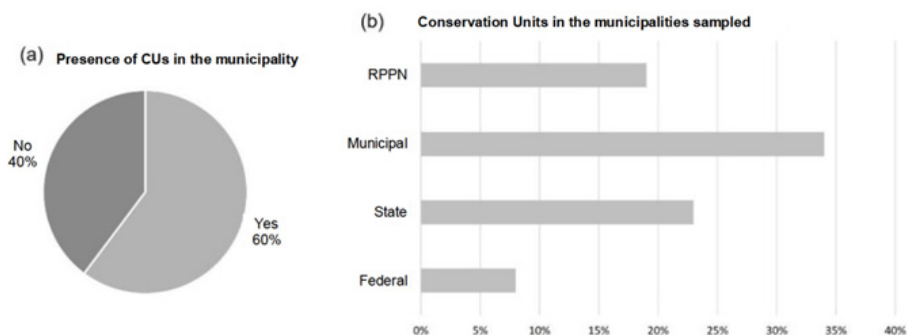


FIGURE 5 – (a) Presence of Conservation Units (CUs) in the municipalities sampled in Minas Gerais and (b) their link to the municipalities, the state or the Federation as specially protected public lands or as Private Natural Heritage Reserves (RPPNs).

SOURCE: Prepared by the authors.

Distribution of the CUs in the three political-administrative spheres throughout the national territory according to the CNUC-MMA database

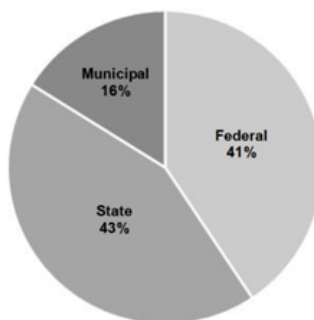


FIGURE 6 – Distribution of the CUs in the three political-administrative spheres throughout the national territory, according to the CNUC-MMA database.

SOURCE: Prepared by the authors based on the CNUC-MMA database (2020).

administration, as in the case of most (67%) of the municipalities sampled.

Municipalities play an important role in the preservation of the native vegetation segments and smaller areas not covered by the federal and state CUs. However, the underrepresentation of the municipal CUs in the national registry indicates that the situation of these areas is still little known.

The understanding that health and social well-being depend on nature, largely supported by science, may be stimulating the interest of municipal public managers and civil society agencies and organizations in the creation of specially protected spaces in the municipalities. Among the factors that have been pointed out as motivators for creating CUs by the municipalities are the following: offering public use areas conducive to leisure, recreation, ecotourism, environmental education and scientific research to the population; protection of areas of hydrological recharge and springs that are important for the cities' water supply and security; conservation of the natural landscape, biodiversity and endangered species; and maintenance and creation of strategic areas for safety and resilience of the cities facing floods and climatic extreme events (Soga *et al.* 2015; SOS Mata Atlântica, 2017).

In addition to these motivations, municipal CUs may reflect in greater *ICMS Ecológico* transfers¹ to the municipality, as provided for by the Minas Gerais State Law No. 18,030 of 2009, known as the Robin Hood Law (Minas Gerais, 2009). According to the “*manual of procedures for*

the registration of municipal conservation units for the purpose of receiving ICMS Ecológico” of the Minas Gerais State Forest Institute (*Instituto Estadual de Florestas*, IEF), “The Conservation Units Subcriteria aims at compensating municipalities that have protected areas and encourage the creation and implementation of CUs, in addition to improving the management quality of these areas” (IEF, 2017).

Sixty-eight percent (68%) of the respondents to this study answered ‘Yes’ when asked whether their municipality received *ICMS Ecológico*. It is known that *ICMS Ecológico* considers three indices²: the “Conservation Index (CI – 45.45%)”, the “Environmental Sanitation Index” (ESI – 45.45%) and the “Dry Forest Index (DFI – 9.1%)” (IEF, 2017). Since according to the answers obtained, the sampled municipalities do not perform well in sanitation indicators (Table 1), their receiving *ICMS Ecológico* must be related to the occurrence of CUs in the municipalities (Figure 5). It is worth noting that, although there are several rules and requirements for the Minas Gerais municipalities to receive *ICMS Ecológico* with regard to the municipal CUs included in their territories, registration to CNU-C-MMA is not required by the Minas Gerais state agency to calculate *ICMS Ecológico* (IEF, 2017), as practiced for environmental compensation.

It was noticed that urban sewage treatment is a central challenge of the sampled municipalities (Table 1), with the sampling of this study according to the official data which indicate that only 42% of sewage is treated in Minas Gerais (National Sani-

¹ “*ICMS Ecológico* is a tax mechanism that seeks to encourage municipalities to promote actions to preserve natural resources, such as legal protection of natural areas or treatment of garbage and sanitary sewage, allowing them to access larger percentages of the financial resources collected by the states through the Tax on Circulation of Goods and Services, the ICMS, due to the fulfillment of certain environmental criteria established in state rules.” (SEMAD MG Portal) (<http://www.meioambiente.mg.gov.br/icms-ecologico>).

² Article 4, Law No. 18,030/2009, Minas Gerais, 2009 (http://www.fazenda.mg.gov.br/empresas/legislacao_tributaria/leis/2009/118030_2009.html).

tation Information System [*Sistema Nacional de Informações Sobre Saneamento*, SNIS], 2019) and that 87% of the population has sewage collection services (*Agência Minas*, 2021). Improving the sanitation indicators is crucial to overcome the “water pollution” challenge, one of the most common in the municipalities sampled (Figure 3). The impact and capacity of the new legal framework for basic sanitation in Brazil (Law No. 14,026 of July 2020) (Brazil, 2020) to contribute to the necessary improvement of this reality is controversial and requires surveillance and monitoring by society (Paganini & Bocchiglieri, 2021).

3.3. Environmental management and public policies regarding sustainability in the Minas Gerais municipalities

Local environmental management faces a series of requirements and challenges related to management and ordering of the territories. The most cited and recurrent ones in the current study were as follows: “lack of resources”, “insufficient staff”, “absence of a long-term political project” and “management discontinuity” (Figure 7).

Lack of economic resources and staff, frequently found in 88% and 56% of the answers,

respectively, retrofied each other negatively as local environmental management challenges. To be achieved, economic resources require staff and technicians capable of preparing and managing projects, preferably involving municipal public management partnerships with other segments, such as other public spheres, companies, universities and organized civil society. Weak institutional environments diminish the capacity of local governments to leverage the public and private resources required to realize the potential of sustainable urbanization to achieve SDG 11 and the New Urban Agenda (UN-Habitat, 2017; 2020). On the other hand, the shortage of economic resources hinders hiring duly qualified personnel to work in the environmental area.

“Absence of a long-term political project” and “management discontinuity” were frequently found in 52% and 48% of the answers, respectively. Such challenges also contribute to the lack of resources and personnel, showing an inverse system and contrary to better environmental management conditions and development of local public policies for sustainability.

There is a clear perception in the scientific literature that Brazilian municipalities have little institutional capacity, mainly reflected in the lack of financial and human resources for municipal environmental management public agencies and ins-

TABLE 1 – Basic sanitation indicators of the municipalities sampled.

Sanitation indicator	Percentage of the population served				Respondents
	0%	Up to 50%	More than 50%	100%	
Sewage collection	8 (9%)	9 (10%)	59 (67%)	7 (8%)	83
Sewage treatment	49 (56%)	15 (17%)	18 (20%)	1 (1%)	83
USW selective collection	40 (45%)	22 (25%)	9 (10%)	11 (12%)	82

SOURCE: Prepared by the authors.

tances – this understanding comes especially from research studies aimed at understanding the context of municipal environmental licensing (Abreu & Fonseca, 2017; Nascimento & Fonseca, 2017; Alves *et al.* 2022). Despite the existence of few research studies on this subject matter, it is also noticed that when the municipalities assume responsibility for environmental licensing of local impact projects, collection increases and municipal environmental agencies present improvements in their conditions (Nascimento & Fonseca, 2017; Alves *et al.*, 2022).

The respondents stated that the environmental laws and standards they most commonly use (Table 2) are the Solid Waste National Policy (PNRS) (Law No. 12,305/2010) (79%) and the Normative Resolutions (*Deliberações Normativas*, DNs) of the Minas Gerais State Council of Environmental

Policy (*Conselho Estadual de Política Ambiental de Minas Gerais*, COPAM), which deal with the criteria and procedures for environmental licensing (72%). In similar proportions in the answers, with slightly over 50%, the National Policy for the Protection of Native Vegetation (Law No. 12,651/2012) (53%), the National Basic Sanitation Policy (*Política Nacional de Saneamento Básico*, PNSB) (Law No. 11,445/2007) (52%) and the Environmental National Policy (*Política Nacional de Meio Ambiente*, PNMA) (Law No. 6,938/1981) (51%) were highlighted.

The result obtained is that the PNRS is the legal regulation most frequently mentioned by the respondents, which reinforces the understanding of the role of municipalities as basic functional units in solid waste management. However, only 12%

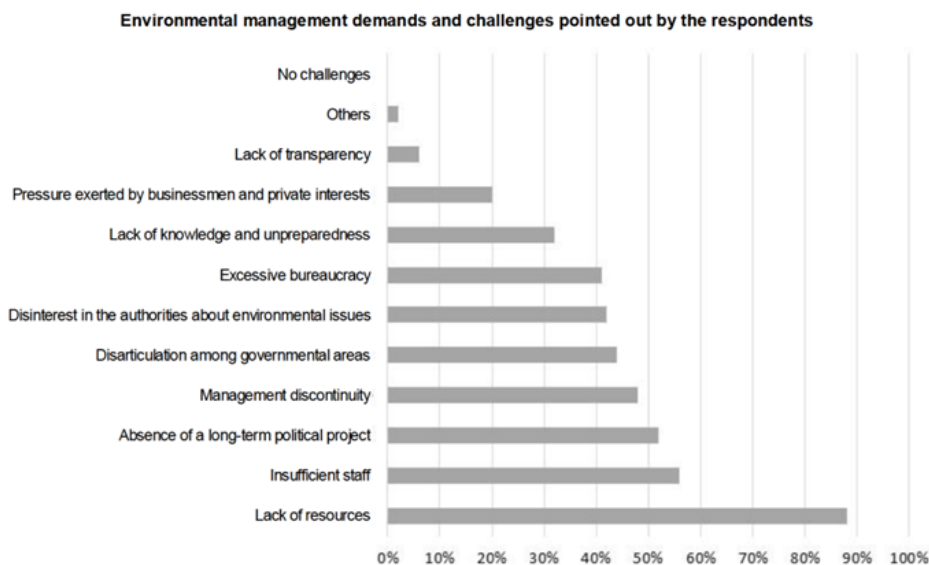


FIGURE 7 – Environmental management requirements and challenges of the Minas Gerais municipalities, according to the frequency of answers given by the respondents to the sampling questionnaire.

SOURCE: Prepared by the authors.

of the respondents said that the municipality has its entire population served by selective collection services, and 45% do not have any percentage of the population served by selective collection (Table 1). When asked about the environmental management mechanisms and instruments that they consider as most useful to their work (Table 3), the Municipal Solid Waste Management Plan was less frequent, mentioned in 41% of the answers.

The expressive frequency of the National Policy for the Protection of Native Vegetation (known as the new Forest Code) (Law No. 12,651/2012) in the answers (Table 2) is attributed to the enormous relevance of this standard for the Brazilian environmental context, as it affects all rural properties and private lands and is vital for the conservation of biodiversity and environmental quality in the country. The observed representativeness of the National Basic Sanitation Policy (Law No. 11,445/2007) (Table 2), whose implementation falls as a central challenge of the sampled municipalities (Table 1), and of the Environmental National Policy (Law No. 6.938/1981) is also expected, both central to

environmental planning and management in the country in all its political-administrative spheres.

The fact that COPAM DN 217 and 213 of 2017 – which establish the environmental licensing criteria, typologies, classification and procedures, respectively, in the state and municipalities of Minas Gerais – were the second option of legal standards most pointed out by the respondents (72%) (Table 2), which can be a result of the recent municipalization process of environmental licensing of local impact projects in the state.

Local Environmental Licensing (LAM) of local impact projects is a competence based on the 1998 Federal Constitution, provided for in Complementary Law No. 140 of 2011 and regulated in Minas Gerais by Normative Resolution (DN) No. 213 of the State Environmental Policy Council (COPAM), dated February 22nd, 2017.

Thirteen (15%) of the 88 responding municipalities have adopted LAM by the period during which this research was conducted (from August 2018 to August 2019). In August 2021, 21 (24%) of the municipalities sampled carry out LAM; therefore, eight municipalities assumed the licensing of local impact

TABLE 2 – Environmental laws and norms most frequently used by the Minas Gerais public and technical managers who answered the sampling questionnaire.

Environmental laws and regulations most commonly used by the responding public managers and technicians	Frequency of the answers
National Solid Waste Policy (Law No. 12,305/2010)	70 (79%)
COPAM Normative Resolutions 213 and 217 of 2017 (Criteria and procedures for Environmental Licensing in MG)	64 (72%)
National Policy for the Protection of Native Vegetation (New Forest Code – Law No. 12,651/2012)	47 (53%)
National Basic Sanitation Policy (Law No. 11,445/2007)	46 (52%)
National Environmental Policy (Law No. 6,938/1981)	45 (51%)
Cities' Statute (Law No. 10,257/2011)	25 (28%)
National Environmental Education Policy (Law No. 9,765/1999)	24 (27%)
National Conservation Units System (SNUC – Law No. 9,985/2000)	19 (21%)
National Climatic Change Policy (Law No. 12,187/2009)	9 (10%)
National Agroecology and Organic Production Policy (PLANAPO, Decree No. 7,794/2012)	8 (9%)
Zoonosis Control Policy (MS Ordinance 1,138/2014) and for Dog and Cat Populations (Law No. 13,246/2017)	5 (6%)
Others	10 (11%)

SOURCE: Prepared by the authors.

projects between August 2019 and August 2021, a 61% increase in a two-year period, considering that most of this time elapsed during the COVID-19 pandemic. Of the 21 sampled municipalities that carry out LAM in 2021, 62% (13) do so in the form of consortia, 29% (6) individually and 9% (2) through technical and administrative cooperation agreements for delegation of state powers to the municipality. The two municipalities (Contagem and Ibirité) that carry out LAM in partnership with the state have high population sizes, which differentiates them from the rest of the sampling and the demographic pattern average observed in mining cities.

Also, with regard to the laws and regulations related to local environmental management, 53

(60%) of the 88 municipalities sampled have some type of municipal law or regulation related to the environment, whether they are municipal environmental policies, municipal sanitation plans, municipal solid waste management plans, urban afforestation plans or instruments for creating the municipal environmental council or municipal conservation unit. The presence of environmental laws of their own in the municipalities sampled in this study is independent of the population size ($\chi^2 = 2.17$; $p = 0.54$; significance level = 0.05) and of the fact that the municipality has assumed responsibility for the environmental licensing of local impact projects ($\chi^2 = 1.44$; $p = 0.23$; significance level = 0.05).

The environmental management mechanisms and instruments that the respondents considered

TABLE 3 – Local environmental management mechanisms and instruments in Minas Gerais considered by the respondents as most useful in their work.

Local environmental management mechanisms and instruments considered most useful by the respondents	Frequency of the answers
Municipal Environmental Council	82 (91%)
Articulation with the state's environmental bodies	58 (64%)
Municipal Basic Sanitation Plan	48 (53%)
<i>ICMS Ecológico</i>	45 (50%)
Rural Environmental Registry (CAR)	45 (50%)
Municipal Master Plan	40 (44%)
Municipal Solid Waste Management Plan	37 (41%)
National School Feeding Program (PNAE)	34 (38%)
National Program for Strengthening Family Agriculture (PRONAF)	30 (33%)
Public-Private partnerships	28 (31%)
Ecological and Economic Zoning	15 (17%)
Reverse logistics for special waste, such as electronic/electrical devices, lamps, and batteries	15 (17%)
Municipal Civil Construction Waste Management Plan	14 (16%)
Environmental Regularization Plan (PRA)	11 (12%)
Sustainable public purchases and bidding processes	9 (10%)
<i>Bolsa Reciclagem</i>	5 (6%)
Environmental Reserve Quotas (CRAs)	4 (4%)
Environmental Reserve Quotas (CRAs)	2 (2%)
Behavioral Adjustment Terms (TACs) corresponding to environmental infringements	1 (1%)

SOURCE: Prepared by the authors.

most useful to their work were the “municipal environmental council” (91%) and the “articulation with the state's environmental bodies” (64%) (Table 3). These results indicate the importance of democratic representativeness and of intersectoriality in environmental management, even at the most local level of the municipalities.

Participation of the citizens is essential for the urban development processes (UN-Habit & Colab, 2019). By design, the environment is a common good, whose preservation and management must be shared by the public power with the community, having in the national, state and municipal environmental councils important democratic and participatory governance arenas provided for in the Constitution. These participatory and representative society councils were weakened and deconstructed by the federal government between 2019 and 2021, notably at the federal and subnational levels, with the enactment of Federal Decree No. 9,759 of April 11th, 2019 (Brazil, 2019) and its repercussion in the curtailment of civic and democratic spaces in Brazil between 2019 and 2022 (Szabó, 2020).

The data obtained in this study on the relevance of municipal environmental councils for the public managers (Table 3) indicate that they may have been less affected by this deconstruction. Contributing to this is the fact that these councils are a necessary condition for municipalities to assume the original competence of environmental licensing of local impact projects in Minas Gerais (COPAM DN 213/2017).

The significant frequency of the “articulation with the state's environmental bodies” as a useful management mechanism for the respondents shows the importance of intersectoral articulation. However, it can also reflect a way of making up

for the lack of resources and staff in the municipalities (Figure 7).

The “municipal sanitation plan” among the mechanisms considered most useful by the respondents, when opposed to the data in Table 1, indicates that these plans are still incipient and that they need to advance in the sampled municipalities.

In turn, “*ICMS Ecológico*” and “CAR” (Rural Environmental Register), both with 50% frequency in the answers (Table 3), match the result indicating that 68% of the municipalities receive *ICMS Ecológico* and the frequency of the National Policy for the Protection of Native Vegetation (Law No. 12,651/2012) among the laws considered most relevant by the respondents (Table 2).

According to the Cities Statute (Law No. 10,257/2001) (Brazil, 2001), the “municipal master plan” (44%) (Table 3) is legally provided for municipalities with more than 20,000 inhabitants, not being mandatory for 67% of the sampled cities.

The “municipal solid waste management plan” (41%) (Table 3) was expected to be a more frequent instrument in the answers, having seen that the PNRS was the law most mentioned by the respondents (Table 2).

The National School Feeding Program (*Programa Nacional de Alimentação Escolar*, PNAE) and the National Program for Strengthening Family Agriculture (*Programa Nacional de Fortalecimento da Agricultura Familiar*, PRONAF) are policy instruments found in the reality of the sampled municipalities (Table 3), reinforcing the importance of family farming in these territories.

Although 79 (90%) of all 88 respondents recognized at least one of the programs and strategies to promote local environmental management, presented in Table 4, only 15 (17%) of the municipa-

lities said that they were members or signatories of at least one of these programs. Eight municipalities stated belonging to the Water Producing Program of the National Water Agency (*Agência Nacional de Águas*, ANA³). The Municipal Plans for the Restoration of the Atlantic Forest⁴, foreseen in the Atlantic Forest Law (Law No. 11,428/2006) (Brazil, 2006), were reported in four municipalities and the 2030 Agenda⁵, in three. The A3P (Environmental Agenda in Public Administration, of MMA⁶), the Iclei⁷ (NGO, Local Governments for Sustainability) and the Environmental Program⁸ (Minas Gerais State Environment Foundation [*Fundação Estadual de Meio Ambiente*, FEAM]) were reported twice each. The Global Mayors' Agreement on Climate and Energy⁹ and the Sustainable Cities Program¹⁰ were mentioned once each. The impact of the municipalities' participation and involvement in these networks and programs to promote better environmental management practices in cities should be accessed in in-depth research and new studies.

The municipalities have several partners in the environmental management of their territories, especially the “environmental police”, the “State Forest Institute (IEF)”, the “technical assistance and rural extension bodies” and the “small family farming producers” (Figure 8). These results are in line with the main local environmental management

mechanisms and instruments identified, which are displayed in Table 3.

The United Nations (UN) Sustainable Development Goals (SDGs) were acknowledged by 72 (82%) of the 88 respondents; however, of these, 25 (28%) marked the option “I have heard of it, but I do not quite understand what it is”. Among the 17 SDGs, the respondents pointed out those they considered most urgent and priority in their territory, with no limits on the answers, from which SDG 6 (Pure water and sanitation), SDG 2 (No hunger), SDG 4 (Quality education), SDG 11 (Sustainable cities and communities) and SDG 3 (Health and well-being) were the most frequent answers, in this order (Figure 9).

There is a growing movement by local and regional governments promoting global agendas, seeking to harness the value of sustainable urbanization to overcome the challenges of this decisive decade to contain global systemic crises, implementing the 2030 Agenda and its SDGs at the local level, closer to the citizens' lives and routines (UN-Habitat, 2020).

However, the data from this study indicate that almost one-third of the local public environmental managers in Minas Gerais do not fully understand the SDGs and 2030 Agenda context. This understanding is reinforced by observing that the respondents indicated the 2021 Agenda in 81% of the answers

³ <https://www.ana.gov.br/programas-e-projetos/programa-produtor-de-agua>

⁴ <https://pmma.etc.br/>

⁵ <https://odsbrasil.gov.br/home/agenda>

⁶ <http://a3p.mma.gov.br/>

⁷ <https://americadosul.iclei.org/>

⁸ <https://ambientacao.meioambiente.mg.gov.br/>

⁹ <http://pactodealcaldes-la.eu/pt-br/>

¹⁰ <https://www.cidadessustentaveis.org.br/inicial/home>

TABLE 4 – Programs and strategies to foster and encourage environmental management in Minas Gerais municipalities recognized by the questionnaire respondents.

Programs and strategies to foster and stimulate local environmental management acknowledged by the respondents	Frequency of the answers	No. of members or signatories
2021 Agenda	64 (81%)	
Water Producing Program	50 (63%)	8
Sustainable Cities Program	35 (44%)	1
National Association of Municipal Environmental Bodies (ANAMMA)	29 (37%)	
2030 Agenda	22 (28%)	3
Environmental Agenda in Public Administration (A3P)	22 (28%)	2
Zero Garbage City (<i>Lixo Zero Institute</i> , Brazil)	20 (25%)	
Municipal Atlantic Forest Recovery Plans (PMMA)	17 (21%)	4
Environmental Regularization Program	17 (21%)	2
Low-Carbon Agriculture Program (LCA)	14 (18%)	
Local Governments for Sustainability (ICLEI)	9 (11%)	2
Global Mayors' Agreement on Climate and Energy	4 (5%)	1
C40 Cities' Climatic Leadership Group	3 (4%)	
CDP Cities	2 (2%)	
Others	6 (7%)	

SOURCE: Prepared by the authors.

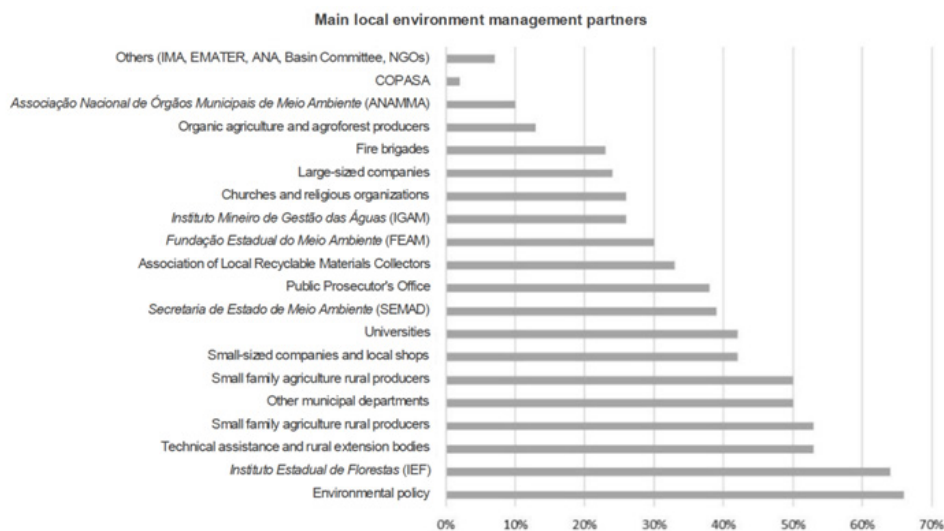


FIGURE 8 – Environmental management partners of Minas Gerais municipalities, according to the frequency with which they were recognized the respondents to the sampling questionnaire.

SOURCE: Prepared by the authors.

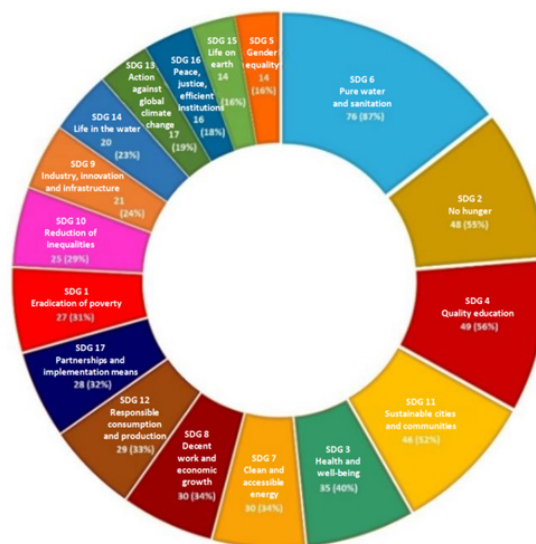


FIGURE 9 – Sustainable Development Goals (SDGs) represented in a mandala where the width of the components represents the frequency of answers given by public managers and technical respondents from the Minas Gerais municipalities sampled, when invited to point out the SDGs they considered most urgent and priority in their territory.

SOURCE: Prepared by the authors.

to programs and strategies to promote and stimulate municipal environmental management, whereas the 2030 Agenda only had a frequency of 28% (Table 4). It is believed that the timid performance by the Brazilian governments, from 2015 to the present day, in strengthening and involving the municipal governments in the definition, implementation and monitoring of urban public policies applied to the SDGs contributes to the context indicated by these results.

3.4. Universities and research and technology institutions in the local environmental management context

Although 57% of the respondents recognize the presence of universities or research institutions in their region and 90% of them identify that these institutions can contribute positively to the challenges experienced, it was noticed that partnerships between local environmental management and universities are still incipient and infrequent. Only 20% of the municipalities indicated universities as frequent partners. Most of the respondents stated that they never (40%) or rarely (30%) had universities as partners in any of their initiatives.

Municipal managers believe that universities can contribute with specialized consultancies (82%), producing and testing innovations (42%) and using municipal environmental management challenges and demands in academic research stu-

dies (41%). Among the main suggestions offered in open answers about topics for academic research are those related to the municipal solid waste management and to its recycling and composting, consistent with the major challenges and opportunities perceived in the municipalities (Figures 3 and 4).

Most of the respondents (85%) understood that digital technologies can be useful in their work, whereas 25% of them stated knowing some technological innovation "startup" company. In open answers, it was noticed that the main contributions that technology can offer to local environmental management are associated with geotechnologies and apps capable of collaborating with municipal solid waste management. There was also an expectation in relation to technologies capable of assisting in the protection and shared supervision of the environment with the population, through the use of technologies that seem to resemble urban janitorial proposals, although this term has not been explained in any of the open answers. Innovations already available with these approaches, such as Colab¹¹, Cataki¹² and BioThanks Collector¹³, seem to be in line with the suggestions offered, indicating that these technologies are still distant from smaller and inland municipalities and that there is a need for stimulus and encouragement to scale these technologies.

More than 90% of the sampled municipal public managers answered "Yes" when asked if they would be willing to be part of a collaborative network for the implementation of public policies for sustainability. This fact shows openness to

strategies and innovations capable of approaching and mediating partnerships between local managers and universities, as well as between research centers and "startup" companies from the environmental area ("green techs").

Potential partnerships and projects involving research studies and innovations applied to local environmental management and sustainable urbanization should pay attention to some important aspects:

- (i) Digital exclusion and inequality in access to the benefits of the new technologies potentiate and deepen social inequalities and castes;
- (ii) Technologies do not substitute improvements in public governance and management;
- (iii) More effective technologies are associated with institutional innovation; and
- (iv) Solutions based on nature, on restoration of the ecosystem services, on harmonic human-nature coexistence and on the net gain of biodiversity should be prioritized. (Bull & Brownlie, 2017; RAPS, 2017; Weins *et al.*, 2017; McVittie & Facioli, 2020; UN-Habitat, 2020).

4. Final considerations and proposals for local environmental management

The program presented in this study reflects the reality of the sampling period, prior to the COVID-19 pandemic and the 2020 local elections. The data and results obtained seek to contribute to understanding the challenges and opportunities

¹¹ <https://www.colab.re/>

¹² <https://www.cataki.org/>

¹³ <https://www.reciclasampa.com.br/artigo/biothanks:-conheca-o-uber-do-entulho>

experienced by environmental management in the Minas Gerais municipalities.

The environmental challenges pointed out by the public and technical managers from the sampled municipalities are synergistic and interdependent, manifesting themselves in the Anthropocene ecological and systemic crises (Marques-Filho, 2018; Veiga, 2019). In general, these challenges can be reversed and minimized through policies, programs, strategies and actions that favor a restorative stance towards biodiversity and the establishment of new sociocultural and economic paradigms, such as sustainability, resilience and interdependence (Solón, 2019; Aronoff *et al.*, 2020; Nascimento, 2020).

It was noticed that there is a favorable scenario for ecological restoration and circular economy in the municipalities sampled, when analyzing the opportunities and challenges perceived by the public managers responding to this research. However, lack of resources, staff and a long-term political project can be identified as the main obstacles to more effective local environmental management, particularly in contributing to multilateral and multiscale governance agreements such as the 2030 Agenda, its SDGs and the Ecosystem Restoration Decade.

The fact that the municipal Conservation Units (CUs) were more common in the sample of this study than their state and federal counterparts is positive but deserves attention since, for the little that is known, municipal CUS are underreported in the Single Registry of Conservation Units (CNUC-MMA), precluding municipalities from benefiting from the environmental compensation mechanisms.

The results obtained lead to understanding that the municipal CUs have met the IEF-MG registration to receive *ICMS Ecológico* and instigate curiosity about the differences between the

national registry (CNUC) and the state ones, which define ICMS. This paper also stimulates the need for a better understanding of the context of under-reporting the municipal CUs in the CNUC-MMA and the impacts it exerts on the municipalities and territories. There is a clear need for more investments in studies, surveys and efforts that seek to understand and integrate municipalities and their CUs in the context of specially protected territories, enhancing the most important and basic aspects of the mechanisms and instruments for biodiversity conservation. In this context, it is pertinent to point out the trend of concession instruments to the private sector of public visitation services in federal and state CUs. This study did not survey the concession instruments or equivalents in the municipal CUs; however, it is suspected that concessions may have potential and viability in these CUs that are under the influence of urban centers and closer to people and civil society organizations.

Cooperation between the federal and state levels with the local governments is essential for an efficient governance capable of optimizing the potential of sustainable urbanization (RAPS, 2017; UN-Habitat, 2020). The data of this study indicate that intersectoriality is practiced between the municipal and state environmental instances, which can be related to standard procedures, such as those related to calculation of the *ICMS Ecológico* that is passed on to the municipalities. However, the general view of the results obtained suggests that this is also due to the municipalities' low institutional capacity.

The partnerships between local environmental management and the universities found in the territory is a potentiality to be boosted, as it is still quite incipient according to the sampling of this

study. It is believed that the strategic cooperation between these actors can contribute to mitigating the main socioenvironmental challenges (Figure 3) and management demands (Figure 7) reported by the municipal public managers. Boosting these partnerships depends both on greater proactivity by the actors involved (researchers, professors, universities, municipal public managers and City Halls) and on policies to promote research and extension targeted at the territories where the universities are, especially public ones. It is recommended that universities, research institutions and innovation and entrepreneurship environments pay attention to the socioenvironmental opportunities and challenges experienced in smaller and more inland municipalities.

It is expected that the data presented in this study may contribute to local environmental management, especially in Minas Gerais, by pointing out the municipalities' gaps, challenges and opportunities in the challenges for more sustainable territories and cities.

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