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Socio-Environmental Impacts in Informal Urban Settlements

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ABSTRACT

Aim – Analyze, critically, the environmental licensing process of informal urban settlements, seeking to improve the instrument in a context of climate change. Methodology - This is a qualitative approach in which the documentary research method was used in environmental licensing processes of informal urban land subdivisions in the Federal District. Originality/relevance - There is a scarcity of studies investigating licensing in informal urban settlements. Considering that environmental licensing is required for activities that may cause socio-environmental damage and aims to mitigate or compensate for such damage, research that empirically evaluates the application of the instrument should be encouraged. Results - In general, environmental licensing in informal urban settlements has not been efficient, mitigation measures are not complied with, monitoring is unsatisfactory, there is a lack of indicators to measure urban environmental quality, and there is a lack of analysis of technological alternatives that consider climate projections and nature-based solutions. Theoretical/methodological contributions: Research on environmental licensing processes for informal urban settlements for low-income (ARIS) and high-income populations (ARINE) has contributed to complement the global literature, focused on investigating the mining and energy sectors. Comparative research on informal urban land subdivision in other socioeconomic contexts is recommended. Social and environmental contributions - Low-income settlements in ARIS are more vulnerable to socio-environmental risks and climate change than settlements in ARINE, requiring greater attention from managers to reduce this vulnerability.

KEYWORDS: Informal urban settlement. Environmental licensing. Urban environmental quality.

1 INTRODUÇÃO

Accelerated and unplanned urban growth, accompanied by the impacts of climate change, increases social vulnerability, especially in urban areas where the poor population lives (AGUILAR, 2008; WEKESA; STEYN; OTIENO, 2011; SOUZA; BRAGA, 2020). By 2050, an urban population of 6.3 billion is projected (WILLIAMS *et al*., 2019). This rapid process of urbanization, when it occurs in an unplanned way, compromises the quality of life in cities, especially in regions of the global south where precarious housing conditions are already faced.

Informal urban settlements are residential occupations not planned or authorized by the competent authorities, therefore are illegal (WILLIAMS *et al*., 2019), they are usually located in environmentally sensitive areas with low availability of basic public services. Climate change exacerbates environmental and human health risks in these urban settlements, exposing the vulnerability of the poorest population (WILLIAMS *et al*., 2019; GIRI *et al*., 2021). More than 1 billion people in the world live in informality (CARRILHO; TRINDADE, 2022). Climate change projections indicate a significant increase in the frequency and intensity of extreme weather events for the coming decades (IPCC, 2022). In this scenario, investigating the socio-environmental impacts to which these settlements are subjected, seeking solutions that can give greater resilience to these areas, can contribute to the academic debate, and provide subsidies to public managers responsible for the decision-making process.

In Brazil, about 5 million households informally occupy the territory (IBGE, 2020). Among the causes of expansion of these areas are the inefficiency of housing programs, the high cost of housing in the formal market, and the high expectation of regularization (JATOBÁ, 2016; SMOLKA, 2008). In the Federal District, capital of Brazil, these informal urban settlements or subdivisions are classified by the Master Plan for Territorial Planning into Regularization Areas of Specific Interest (EPRA), occupied by medium and high-income populations, and Regularization Areas of Social Interest (SIRA), occupied by low-income population. In the process of regularization of these areas, urban and environmental licensing is carried out, aiming to

ISSN 2318-8472, v. 12, n. 86, 2024

promote improvements in the quality of life of the population and conservation of natural resources. For this research, the words urban settlement and urban land subdivision are interchangeable.

The advance of informal urbanization in the Federal District (FD) in the last three decades has intensified social inequality, environmental degradation, and the vulnerability of the needy population. Impacts caused by climate change (heatwaves, heavy rainfall, floods, prolonged droughts, water scarcity, damage to human health) contribute to this scenario. In Menezes *et al*., (2016) the projections for the next three decades in the FD are a temperature increase between 1°C and 3°C, with a reduction in rainfall and an increase in the intensity of precipitation in a shorter period. As in other Brazilian cities, the FD experienced heat waves in 2023 recording record temperatures (INMET, 2023). Therefore, climatic variations with extreme events tend to be increasingly frequent and intense, indicating the need for actions to adapt and mitigate the socio-environmental impacts that these events can cause.

In this context, investigating public policy instruments that can contribute to mitigating the impacts caused by rapid unplanned urbanization is a way to build greater urban resilience to climate change. The term resilience in this paper refers to the ability of areas affected by environmental hazards or climatic events to effectively reduce, accommodate, and recover from the harmful effects (SATTERTHWAITE et.al, 2020). In this research, the environmental licensing process was selected, the main instrument of the National Environmental Policy of Brazil instituted more than four decades ago, in which socio-environmental impacts are evaluated and mitigating or compensatory measures are defined for projects capable of causing socio-environmental damage. The aim of this work is to critically analyse the process of evaluation of socio-environmental impacts in environmental licensing in EPRA and SIRA. Specifically, to characterize the socio-environmental impacts in these areas and the capacity for resilience, seeking to improve the instrument in a context of climate change. This research aims to contribute to filling a gap in the literature regarding investigations of informal urban land subdivisions from the perspective of an environmental instrument of command and control. Academic studies have focused on energy and mining sectors (APPIAH-OPOKU; BRYAN 2013; DUARTE; DIBO; SÀNCHEZ, 2017; BREDARIOL; D'ÁVIGNON, 2018; LIMA; MARIANO; ABRAHÃO, 2019; ARAÚJO, 2019; ALVES et., 2020; SOUZA; ALMEIDA, 2020).

2 METHODOLOGY

2.1 AREA OF STUDY

The FD occupies an area of 5,783 km² and is geographically inserted in the Cerrado biome. Its headwaters contribute to three Brazilian river basins: Paraná, São Francisco, and Tocantins-Araguaia. It has a marked geomorphological complexity, with altitudes ranging from 950 m along the main rivers to 1,400 m in the plateaus (CHELOTTI; SANO, 2023). The water drainage network in the Federal District is composed of small watercourses with low flows, many springs and large aquifer recharge areas. Unplanned urban growth on this water network impacts the hydrological cycle by sealing recharge areas, compromising the availability of water for human supply and for biodiversity, especially in periods of prolonged drought (CAMPOS,

GC Revista Nacional de Gerenciamento de Cidades
National Journal of City Management

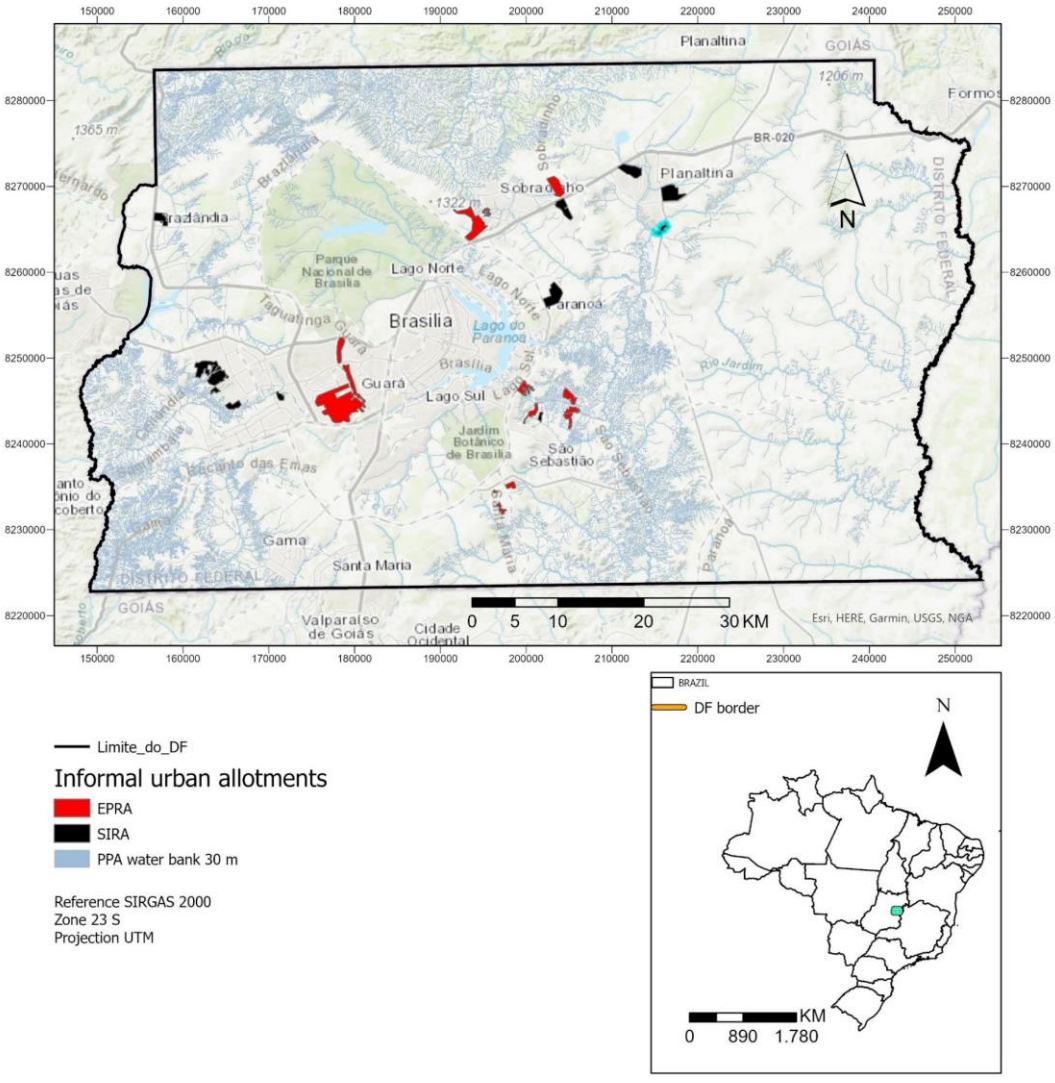
ISSN 2318-8472, v. 12, n. 86, 2024

2004; DF, 2018). In the paper of Seraphim and Bezerra (2019), it was found that about 81% of the urbanized areas in the FD are located on areas of high or very high aquifer recharge potential and 90% of the suppressed vegetation cover occurred on these areas between 1953 and 2016.

The informal urban expansion of housing in the northeast region of the Federal District has resulted in reduction in the volume of water in tubular wells (CAMPOS, 2004; SERAPHIM; BEZERRA, 2019). Therefore, considering that in recent years it has been observed that rainfall rates in the DF have remained below average, and the water crisis between 2015 and 2017 that compromised the supply of the population, efforts are needed from managers and society to adapt, mitigate, or compensate the socio-environmental damage caused by informal urbanization, aggravated by climate change.

For this study, 26 processes of informal urban settlements were selected, 12 in EPRA and 14 in SIRA (Figure 1). Based on other similar academic studies with a qualitative approach, samples between 20 and 30 processes may be sufficient to reach the saturation level of the research (SWANEPOEL *et al*., 2019).

Figure 1. Permanent Preservation Area (PPA) of watercourse, informal urban subdivisions, and boundary of DF.



Source. Authors. GEOPORTAL/FD database, 2023.

ISSN 2318-8472, v. 12, n. 86, 2024

The dominance of public lands in the Federal District, about 61%, instead of favouring the formal occupation of urbanized lands, ended up favouring the advance of low, middle, and high-income informal housing (SEDUH, 2021). The Master Plan of the Federal District acted more as a remediator of informal urban occupations, mapping informality and defining areas of regularization, than as an instrument of urban development planning.

2.2 PROCEDIMENTOS METODOLÓGICOS

The geographical area of this research is the territory of the Federal District. This study has a predominantly qualitative approach based on documentary analysis (CRESWEL, 2007). Data collection was carried out through the environmental licensing processes of informal urban settlements (SIRA and EPRA) within the scope of Brasília Ambiental (IBRAM), the environmental agency responsible for environmental licensing in the Federal District. This type of methodological procedure has been used in other academic studies (PÖLÖNEN; HOKKANEN; JALAVA, 2011; ALMEIDA et al., 2019; MORRISON-SAUNDERS et al., 2021).

For this study, processes that received an environmental license in the period from 2017 to 2022 were selected. This selection was based on two criteria: the first is to select only processes with a license, as it is intended to evaluate the control measures (mitigating, reparative or compensatory) adopted after the issuance of the license. The second is related to the ease of access to the processes starting from 2017, when they began to be processed digitally, in the Electronic Information System – SEI, allowing the collection of data quickly and remotely. In all, there were 37 licensing processes for informal urban land subdivisions that had already received an environmental license in the period of interest of the research. Licensed areas smaller than 20 hectares were excluded because they require more simplified procedures, leaving 26 urban settlements for analysis of this research, 12 in SIRA and 14 in EPRA (Table 1).

ISSN 2318-8472, v. 12, n. 86, 2024

Table 1. List of environmental licensing processes selected with their respective case number, proposer, settlement code and licenses.

N	SIRA PROCESS	PROPOSER	CODE*	ENVIRONMENTAL LICENSE
1	391-00006499/2019-94	Public	SNT2	LI 24/2021
2	391-00003597/2019-70	Public	PS	LI 5/2021
3	391-00003110/2019-59	Public	NC	LI 1/2022
4	391-00016669/2017-87	Private	MD	LI 10/2019
5	391-00016494/2017-16	Public	SNT3	LI 32/2018
6	391-00006300/2019-28	Public	IT	LI 4/2021
7	391-00005329/2019-92	Public	PR	LI 3/2021
8	391-00000181/2018-19	Public	VSJ	LI 1/2018
9	391-00007493/2018-53	Public	SS	LI 1/2020
10	391-00005330/2019-17	Public	VA	LI 7/2022
11	391-00002960/2018-59	Private	AR	LI 9/2018
12	391-00017836/2021-93	Public	SNT1	LI 9/2022
1	391-00019959/2017-82	Private	BV	LI 21/2020
2	391-00018206/2017-50	Public	SB	LI 4/2021
3	391-00016876/2017-31	Private	SO	LI 42/2017
4	391-00016800/2017-14	Private	QS	LI 3/2020
5	391-00016760/2017-01	Private	CI	LI 11/2018
6	391-00017706/2017-74	Private	C2	LI 12/2019
7	391000021052/2017-83	Private	SF2	LI 4 /2018
8	391-00012643/2017-60	Private	CV	LI 4/2019
9	391-00016662/2017-65	Private	PM	LI 6/2018
10	391-00021199/2017-73	Private	GC	LI 5/2020
11	391-00014599/2017-22	Private	BG	LI 3/2018
12	391-00020770/2017-32 391-000743/2012	Public	BS	LI 2/2020
13	391-00004908/2019-18	Public	VP1	LI 3/2022
14	391-00020770/2017-32	Public	ARN	LI 5/2018

* The names of the urban settlements were coded for a better graphical presentation of the results. LI: Installation License.
Source: Authors.

After proceeding to the analysis of the documents of interest to this work (environmental license applications, environmental studies, technical opinions, environmental licenses, inspection, and monitoring reports), qualitative data (types of impacts and constraints) were tabulated in an Excel spreadsheet. Quantitative data (size of the area and number of lots in the settlements, frequency of types of socio-environmental impacts, and control measures requested and executed) were also tabulated. The data were analysed with descriptive statistics and the results were shown in graphs.

3 RESULTS AND DISCUSSION

3.1 CHARACTERIZATION OF URBAN SETTLEMENTS IN SIRA AND EPRA

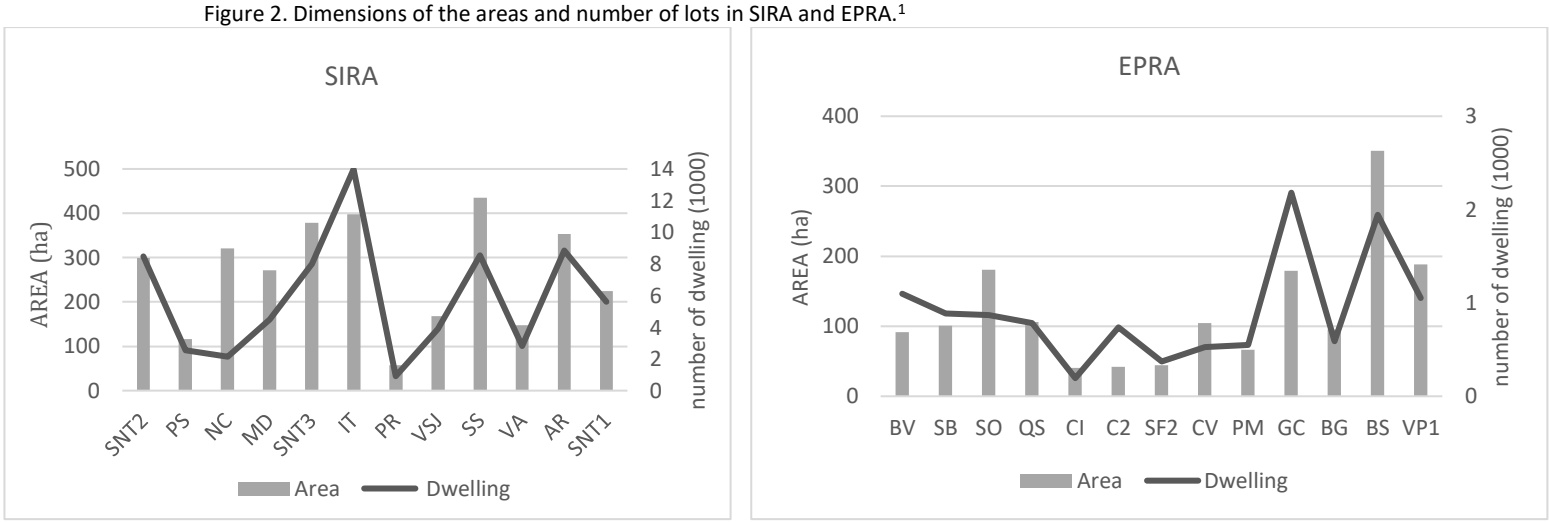
The total area of informal urban settlements analyzed is 5,763.63 hectares (ha), of which 2,984.52 (ha) in SIRA and 2,779.11 (ha) in EPRA. Although the size of the areas is approximate, the density of dwelling in areas of social interest is significantly higher. The number of dwellings in SIRA was 65,759, almost double that of EPRA, 30,480 (Figure 2). Urban

GC Revista Nacional de Gerenciamento de Cidades
National Journal of City Management

ISSN 2318-8472, v. 12, n. 86, 2024

settlements for populations with higher purchasing power have green areas and low-density occupations, dispersed in the territory in a diffuse way (urban sprawl). On the other hand, the settlements for poorest populations are occupied with high density in a compact and precarious way, with little or no green area. Urban green areas promote human health benefits, reduce exposure to air pollutants, noise, and excessive heat (BRAUBACH et al., 2017). Green areas also contribute to the infiltration of rainwater in aquifer recharge areas, retardation of rainfall runoff (reducing peak flows) and conservation of biodiversity (DAVIS; NAUMAN, 2017). Therefore, settlements in EPRA, with higher green area coverage, are less vulnerable and more resilient than low-income urban settlements in SIRA.

Figure 2. Dimensions of the areas and number of lots in SIRA and EPRA.[1]



Source: Authors.

Although the literature shows that urban occupations by populations with lower purchasing power are associated with areas of greater environmental sensitivity (AGUILAR,2008; FERNANDES, 2011; LOCATELLI, 2021), the higher income classes also exert pressure in these areas. Of the 26 environmental licensing processes analyzed, 21 had urban occupations in PPAs (12 in EPRA) and 6 in Water Source Protection Area (3 in EPRA). The occupations in PPAs varied in their typologies (springs, hydromorphic soil in *veredas*, banks of watercourses, plateau edges, and slope > 45^0). The most common occupation was on the banks of watercourses, like the results of the surveys by Mesquita, Silvestre, Steinke (2017) and Seraphim and Bezerra (2019). The vegetation of these areas protects watercourses, provides natural resources for the biota, promotes carbon sequestration, allows the regulation of water flow and thermal comfort, contributing to mitigate the impacts caused by climate change (SILLS, 2023). In this sense, both low- and high-income settlements are compromising these ecosystem functions that are essential to the quality of human life and maintenance of biodiversity.

[1] The ARN code was not inserted in the EPRA chart, because its values are very discrepant (area: 1,188.90 and lots: 18,693), impairing the visualization of the chart.

ISSN 2318-8472, v. 12, n. 86, 2024

The discussion of PPA in urban areas has generated academic debates and management conflicts between the right to housing and the right to an ecologically balanced environment, both enshrined in the Brazil Federal Constitution. The enactment of Law N^0. 14,285/2021, which establishes that municipalities will have the power to regulate the protection strips on the banks of water bodies, amending the Forest Code, intensified the debate. The municipality of Encruzilhada do Sul/RS, for example, enacted a law allowing the construction of houses less than 5 meters from the bank of the watercourse (the minimum limit required by the Forest Code is 10 meters). This type of political movement, when not technically based, can expose communities to greater social vulnerability to the effects of floods, aggravated by heavy rainfall. Therefore, after extensive discussion with society and experts, it is necessary to reach a technical and social consensus without prejudice to the right to decent housing and environmental protection. The simple definition of a fixed protection strip for urban PPAs does not seem to be the way, it is a reductionist and merely political vision that disregards climate projections, city dynamics and ecological processes.

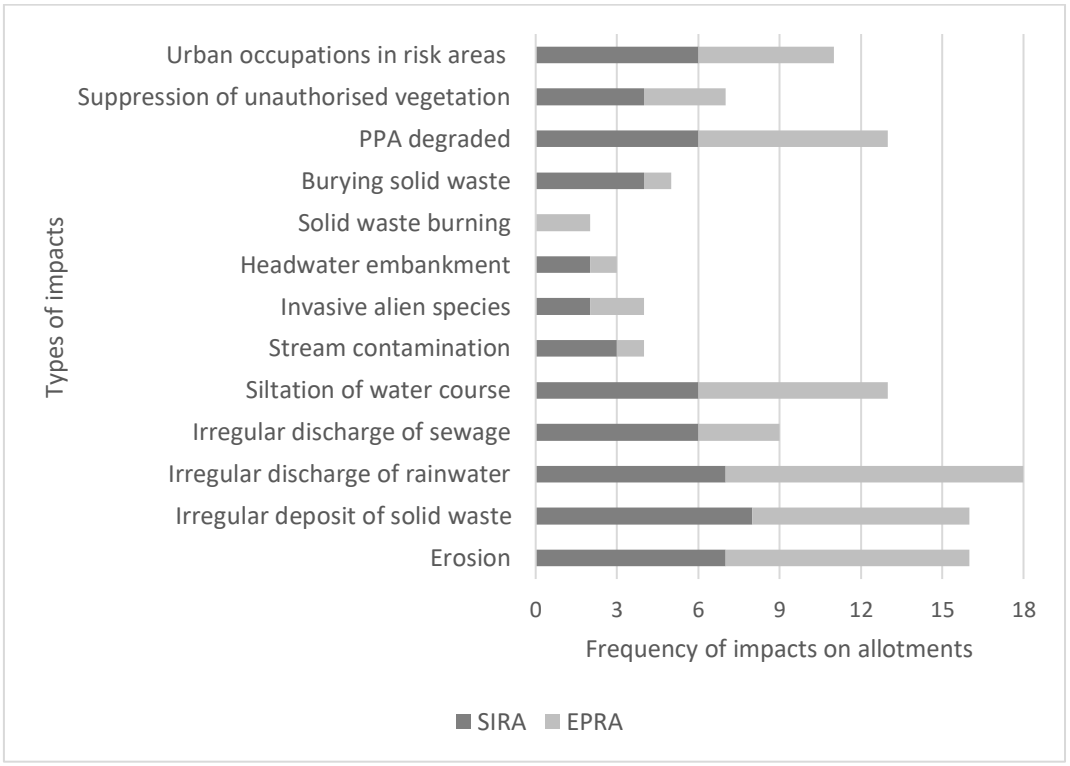
Urban, environmental, and housing development policies should act in an integrated manner in the process of requalification of informal urban settlements. For Peres and Cassiano (2019) and Abreu and Peres (2021), urban and environmental integration favors the prevention and mitigation of urban socio-environmental impacts. In São Paulo, for example, the environmental quota was instituted, which would be a set of occupation rules that make each dwelling in the city contribute to the improvement of environmental quality (SÃO PAULO, 2016). The parameters of the quota are related to rainwater drainage, microclimate, and biodiversity. Although it has limitations and requires periodic reviews, it is an instrument in which climate, environmental and infrastructure variables are integrated into a decision-making process that favors urban resilience.

3.2 **SOCIO-ENVIRONMENTAL IMPACTS OF INFORMAL URBAN SETTLEMENTS**

After documentary analysis of the inspection and monitoring reports, 13 types of socio-environmental impacts in the settlements were quantified. The most frequent is irregular discharge of rainwater, occurring in approximately 70% of the areas studied (11 in EPRA and 7 in SIRA). For this research, irregular rainwater discharge is the absence of rainwater drainage structures that use control mechanisms to avoid flooding, erosive processes, silting of water bodies and degradation of PPAs. The irregular disposal of solid waste, erosion processes, degradation in PPAs and silting of water courses were impacts found in at least half of the subdivisions studied (Figure 3). Urban occupations in risk areas (geotechnical and flooding) were verified in 11 areas (6 in SIRA and 5 in EPRA), while the irregular discharge of sanitary sewage was verified in 9 areas (6 in SIRA and 3 in EPRA). Suppression of vegetation unauthorized, irregular garbage landfill, proliferation of invasive alien species, contamination of water courses, and burning of solid waste were the least frequent impacts in this study.

ISSN 2318-8472, v. 12, n. 86, 2024

Figure 3. Frequency of social and environmental impacts.



Source: Authors.

The absence or inefficiency of a rainwater drainage system for an urban occupation causes inadequate rainwater runoff, which can aggravate the formation of erosive processes, silting of watercourses, flooding, damage urban infrastructures, contribute to the proliferation of waterborne diseases and increase the risks of physical integrity of the population. Irregular deposits of solid waste aggravate this scenario by contributing to the contamination of soil and water resources, in addition to the risk of diseases to human health. The advance of soil sealing caused by unplanned urbanization, in addition to the impacts described above, also generates negative effects on the thermal comfort of the population causing heat islands (MONTEIRO et al., 2022), especially in dense occupations such as SIRA. In addition, most of the urban settlements studied are located on aquifer recharge areas, compromising water quality and availability.

Therefore, including in the regularization process the effective evaluation of alternative technologies that include the climate variable and techniques that favor water infiltration in aquifer recharge areas contributes to the mitigation of these impacts. Green infrastructure or nature-based solutions are promising alternatives to these problems such as the use of bioengineering, green roofs and walls, porous road pavement, *biovaletas*, rain gardens, urban agriculture, and linear parks (ADEGUN, 2017; LAFORTEZZA; SANESI, 2019; MONTEIRO, 2022; BUSH; DOYIN, 2019 DIEP; DODMAN; PARIKH 2019). However, the application of these technologies requires multidisciplinary socio-spatial and technical knowledge, with the proper articulation of the actors involved and effective participation of the community. If the project does not connect with the demands of the community, the chance of failure is high.

ISSN 2318-8472, v. 12, n. 86, 2024

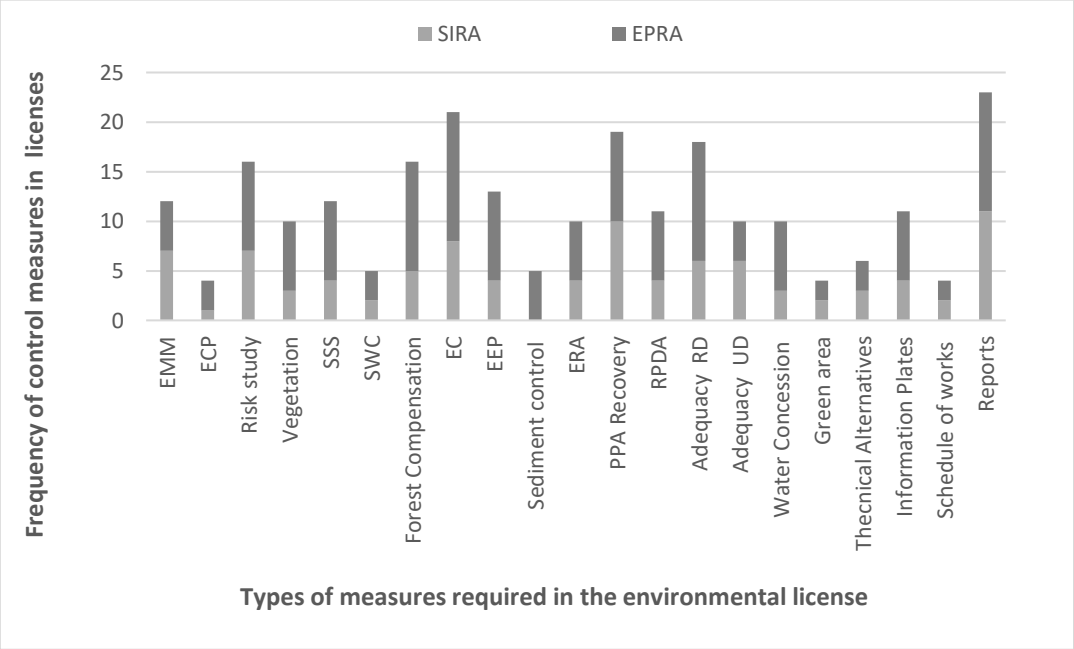
Another relevant and highly polluting impact found in the research is the irregular discharge of sanitary sewage, which is more frequent in SIRA. In these densely occupied areas, when located in a physical environment unsuitable for urban constructions, the costs of implementing a sanitary sewage system for the resident population increase. These obstacles were also found in the studies of Mesquita, Silvestre and Steinke (2017), Costa and Miyazaki (2022), Aguilar (2008), Souza and Braga (2020), showing that the development and execution of basic sanitation projects for these communities is a difficult barrier to overcome. Academia has an important role to play in investigating possible solutions to this type of problem. In the research by Manga, Bartram, Evans (2020), technological alternatives and the costs of sanitation in informal urban settlements in Africa were analyzed. The authors compared three technological models (simplified sewage, dry toilet with urine diversion, and latrine ventilated) and concluded that the simplified sewage system was the best choice for the community studied. This type of evaluation of technological alternatives, both for sanitary sewage and for rainwater drainage systems, is rare in environmental and urban licensing processes (NITA et al., 2022; KAHANGIRWE; VANCLAY, 2022). Land parceling infrastructure projects are usually conventional (gray infrastructure), no effectively address more sustainable alternatives or climate projections in their conceptions, compromising the mitigation of socio-environmental damage caused by climate change.

3.3 IMPACT CONTROL MEASURES (MITIGATING, REPAIRING AND COMPENSATORY)

In all, 21 control measures related to the environmental licensing process of informal urban subdivisions were categorized (Figure 4). The measures were taken from environmental permits issued in the period from 2017 to 2022. The most recurrent constraints for EPRA were the need to carry out Environmental Compensation (EC) (monetary compensation for impacts that cannot be mitigated), Adequacy of Rainwater Drainage (need to adapt the rainwater drainage system) and presentation of Reports (reports on compliance with the conditions of the environmental license). Less frequently, Erosion Control Programs, Solid Waste Collection, maintenance of Green Areas, Technical Alternatives and Schedule of Works were required.

ISSN 2318-8472, v. 12, n. 86, 2024

Figure 4. Frequency of the most required conditions in the environmental license.



EMM=Execution of Mitigating Measures; ECP= Erosion Control Program; SSS=Sanitary Sewage System; SWC=Solid Waste Collection; EC= Environmental Compensation; EEP=Environmental Education Program; ERA=Evacuation of Risk Area; PPA= Permanent Preservation Area; RPDA=Recovery Plan for Degraded Areas; RD= Rainwater Drainage UD = Urban Design.
Source: Authors.

For SIRA, the most common requirements were Reports and PPA Recovery. The lower frequency conditions were the same as those observed for ARINE, adding the need to present the Water Concession of the right to use water resources. Thus, the requirement for Reports is common for both EPRA and SIRA. This documentary concern in the environmental licensing process is criticized by the literature instead of paying more attention to real situation of the licensed area (MACHADO; AGRA-FILHO, 2021; KAHANGIRWE; VANCLAY, 2022). In general, although the requirements are related to the impacts, they are generic and are not mitigating measures for the most part. There are no conditions that establish parameters or indicators for assessing the urban environmental quality of licensed settlements. As verified in the study by Gaio (2023), the climate variable is not effectively integrated in the projects to regularize the environmental licensing of the urban settlements.

Regarding compliance with the conditions required in the environmental license, the most non-complied with was related to Environmental Compensation (EC), in 94% of the processes that were required were not complied with. Although in some cases a Term of Commitment is signed for the payment of the compensation, the proponent prolongs the execution of the payment, not settling its debts. The EC values extracted from the processes in which the information was available ranged from R$ 286,951.26 to R$ 51,254,861.51 depending on the Degree of Impact (size, location, environmental and socioeconomic factors) and Reference Value (sum of costs and investment for the settlement). In none of the settlements was there an analysis of value abatement for the use of green or sustainable technologies, although there is a legal provision. Therefore, there is still little interest, lack of knowledge or

ISSN 2318-8472, v. 12, n. 86, 2024

insecurity of designers in the elaboration of green infrastructure projects or the use of low-carbon technologies for informal urban settlements in the Federal District. The lack of regulation and training for these types of alternative projects can be one of the reasons for professionals' insecurity.

Most of the other required conditions were not complied with in at least 60% of the processes analyzed. The conditions that had the best percentage of compliance were those related to the Presentation of PRAD and installation of Licensing Information Boards or Risk Warning. In view of this non-compliance, of the 26 processes analyzed, 19 had notification of the inspection (14 in EPRA and 5 in SIRA). However, although the inspection promotes the regularization of pending proceedings, it does not guarantee improvements in the environmental and urban conditions of the settlements, especially if the requirements are not defined in detail and if the sanctions are not sufficient for the proposer to adopt the necessary control measures in practice.

In general, the environmental licensing process of urban settlements in EPRA and SIRA has not achieved the expected results in the execution of the control measures provided for in the environmental license. Most environmental requirements are not being met. The fragility in the stage of monitoring and execution of the agreed measures was also found in the surveys Appiah-Opoku and Bryan (2013), Chang *et al*., (2018), Rodríguez-Luna *et al*., (2022). The environmental instrument seems to function more as a notarial piece, dissociated from instruments of other public policies, in which documents, reports, projects and studies are presented to obtain the environmental license. After the license grant, there is no progress of the instrument in the sense of providing better environmental and urban conditions or measures that can mitigate the negative effects of climate change, especially in SIRA.

In this context, one of the ways to improve the environmental licensing process in informal urban settlements would be to integrate urban, environmental, and climatic data with the demands of the communities for project design and decision-making. In addition to the use of technological tools, it is necessary to give greater transparency to this process, making all data available, georeferenced, in a public online database with easy access for all interested parties. In the process of urban land regularization, the Government should not focus only on the title deed, tax collection and issuance of bureaucratic documents. It is essential in the requalification of areas, effectively recovering those already degraded and implementing infrastructure that provides better urban environmental quality and greater resilience to the impacts of climate projections.

4 **CONSIDERAÇÕES FINAIS**

The neglect of the physical, environmental, and social conditions of the territory in a context of increased urbanization in the process of urban development can compromise sustainability in cities, increasing social vulnerabilities to extreme events caused by climate change. With the projected increase in the urban population in the world in the coming decades, the challenge of environmental and urban management involves mainly four aspects: informal urban settlements, precariousness of urban infrastructure, environmental degradation, and social vulnerability to climate change. In this research, these aspects were explored within the

ISSN 2318-8472, v. 12, n. 86, 2024

scope of the environmental licensing process of informal urban settlements with the objective of characterizing these areas, identifying the socio-environmental impacts, mitigating measures, and proposing recommendations for improving the process in a context of climate change.

Both in medium and high-income (EPRA) and low-income (SIRA) urban settlements, socio-environmental impacts that compromise urban environmental quality were verified. The most frequent impact was the irregular discharge of rainwater. The results indicate that urban environmental degradation in informal subdivisions may be correlated with the absence or precariousness of infrastructure, regardless of social class. However, low-income housing are more likely to cope with this critical scenario and have lower resilience to extreme weather events than occupations in EPRA. In this sense, the studies and projects that are part of the requalification of these areas (urban, environmental and infrastructure) must consider the demands of the population, be integrated between the sectors involved and be open to the feasibility analysis of more modern non-conventional technical alternatives such as nature-based solutions.

The environmental licensing instrument proved to be ineffective in promoting greater climate resilience and better environmental and urban conditions for the settlements investigated. Although environmental requirements are related to socio-environmental impacts, there are no parameters or indicators that evaluate the evolution of improvements in the urban environmental quality of the settlements. The monitoring stage is unsatisfactory, the required mitigating and compensatory measures are not being executed, and there is a greater focus on procedural documents. In this scenario, the following recommendations are suggested for improving the instrument:

- Cooperation and integration of urban, environmental, and climatic data for the development of infrastructure projects in an official public database that is easily accessible to society.
- Periodic meetings between environmental consultants, environmental agency analysts, urban planners, and designers with the participation of academia and community leaders for more complex studies.
- Elaboration of socio-environmental indicators to measure improvements in the urban environmental quality of settlements.
- Consider the demands of the communities, the climatic variable, technical alternatives for rainwater infiltration in aquifer recharge areas, and nature-based solutions in the preparation of studies and projects. The training of the actors involved in this process is essential.
- Grant benefits to proponents who adopt good socio-environmental practices with low carbon emissions (longer validity period of licenses, priority of analysis, socio-environmental certifications, access to specific credit lines).

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