

Drainage system and urban planning in the city of Campinas/SP

Cibele Roberta Sugahara

Professora Doutora, Programa de Pós-Graduação em Sustentabilidade, PUC Campinas, Brasil
cibelesu@puc-campinas.edu.br

Denise Helena Lombardo Ferreira

Professora Doutora, Programa de Pós-Graduação em Sustentabilidade, PUC Campinas, Brasil
lombardo@puc-campinas.edu.br

Walef Pena Guedes

Mestrando do Programa de Pós-Graduação em Sustentabilidade, PUC Campinas, Brasil
walef.pg@puccampinas.edu.br

ABSTRACT

The need to plan the territory is relevant in urban regions with a dense population. For the expansion of cities to be sustainable, it is important that the urban area is planned in an integrated manner. The procedures to carry out this planning depend on both the formulation and the management of sectorial and regional plans, whether they are municipal, state or federal. As it is a complex issue, the infrastructure of water supply networks, the collection of sanitary sewage, the drainage system, among others, should be reviewed. The aim of this article is to present the relevance of the drainage system in urban planning in expanding urban regions such as the city of Campinas/SP. To meet the objective of the study, the research method is characterized as descriptive and documental and Case Study. For this purpose, data from the National Sanitation Information System of the city of Campinas/SP on hydrological events with specific characteristics, were selected. The results show that since 2015 the municipality has had hydrological risk warning systems, as well as carrying out comprehensive mapping of areas at risk of inundations in urban watercourses. It is concluded that the city of Campinas has suffered from problems related to surface water flow, a consequence of the high degree of urban densification and the increase in impermeable areas.

KEYWORDS: Basic Sanitation. Drainage System. Urban Planning.

INTRODUCTION

In large urban regions, population density is a reality, motivated by opportunities generated by economic activities or better quality of urban life. Ferreira (2011) points out that more than half of the world population lives in urban environments. However, from this reality emerges issues such as the need to plan the urban environment considering the infrastructure of water supply networks, the collection of sanitary sewage, the drainage system, among others.

The world scenario signals the need to provide water in quality and quantity to serve the population. Furthermore, the Brazilian reality marked by social inequality reinforces the importance of universalizing the services of water supply, basic sanitation, urban drainage, among other factors.

Given the complexity of this infrastructure, public administration through municipal management projects, such as the city's Strategic Master Plan, must foresee a framework with clear guidelines for the expansion and management of the territory.

In the case of the city of Campinas/SP, the 2018 Strategic Master Plan, Complementary Law No. 189 of 01/08/2018 brings together several elements aiming to preserve environmental assets. With regard to environmental management, the Campinas Master Plan establishes management guidelines for surface and underground water, the built and cultural environment, soil contamination, basic sanitation, urban drainage, etc. (BRASIL, 2018).

According to the Municipal Secretariat for Urban Development of the State of São Paulo, the urban drainage system integrates the set of public infrastructure in an urban area. This system involves: "water supply networks, sewage collection, energy transmission cables, communication services, in addition to public lighting, street paving, sidewalks and curbs, parks, recreation and leisure areas" (SMDU, 2012, p. 14).

For the expansion of cities to be sustainable, it is important that the urban area is planned in an integrated manner. The procedures to carry out this planning depend on both the formulation and the management of sectorial and regional plans, whether they are municipal, state or federal. According to SMDU (2012, p. 14) the fundamental issue is to clearly express the points of compatibility between the urban drainage plan and the sectorial/regional plans. Therefore, recognizing the importance of alignment between the drainage system since the beginning of the urban planning formulation is the main condition for the success of the expansion or orderly maintenance of the territory.

There will always be rainwater runoff, regardless of the existence of an adequate drainage system, however the quality of this system will result in benefits or harm to the population.

The question that we intend to answer in this study is to show the importance of the drainage system in the urban planning observed from the Municipal Strategic Master Plan of the city of Campinas/SP.

This article aims to present the relevance of the drainage system in urban planning in expanding urban regions such as the city of Campinas/SP.

METHOD

Para atender ao objetivo do estudo o método de pesquisa caracteriza-se como descritivo e documental e Estudo de Caso. Segundo Richardson (1999) o estudo de natureza descritiva possibilita a identificação de características de fenômenos sociais. Os objetos de estudo podem ser “uma situação específica, um grupo ou um indivíduo” (RICHARDSON, 1999, p. 71).

To meet the objective of the study, the research method is characterized as descriptive and documental and Case Study. According to Richardson (1999), the descriptive study allows the identification of characteristics of social phenomena. The objects of study can be “a specific situation, a group or an individual” (RICHARDSON, 1999, p. 71).

The object of study investigated in this work refers to the situation of urban drainage in relation to the Campinas city Master Plan. In addition, data from the National Sanitation Information System (SNIS) on drainage and information available in the 4th Diagnosis of Drainage and Management of Urban Stormwater document for the year 2019, prepared by the National Sanitation Secretariat - Ministry of Regional Development, were selected.

The collection included data on the number of households at risk of inundations, number of inundations, torrents, floodings not registered in the Integrated Disaster Information System (S2ID).

The city of Campinas was chosen as a case study considering the pressure on water resources due to population density. The choice is justified in view of the guidelines of the Integrated Urban Development Plan (PDUI), which reinforces the importance of territorial ordering with drainage and infiltration actions for a more controlled flow of floods, floodings and torrents in the Metropolitan Region of Campinas (MRC).

BASIC SANITATION AND URBAN DRAINAGE

Sanitation comprises the services of “water supply; sewage collection and treatment; urban cleaning, garbage collection and disposal; drainage, and rainwater management” (ANA, 2020, s/p). In order to adequately provide such services, Brazil currently has 60 subnational Agencies operating in the sanitation sector. Out of this total, 25 are state, 28 municipal, 6 intermunicipal and 1 district (ANA, 2020).

The scenario of continuous and accelerated changes fostered the creation of the National Basic Sanitation Policy (PNSB) in 2007, which stipulates and ensures that sanitation must include water supply, in addition to covering infrastructure and installation for the supply of drinking water to the population.

According to Brasil (2007, n/p) sanitation according to the PNSB involves "a set of services, infrastructure and operational facilities for the supply of drinking water, sanitary sewage, urban cleaning, solid waste management and drainage and rainwater management".

In 1981, the National Environmental Policy (PNMA) was created, whose objective is "the preservation, improvement and recovery of the environmental quality propitious to life, aiming to ensure, in the country, conditions for socio-economic development, the interests of national security and to the protection of the dignity of human life" (BRASIL, 1981). Among the PNMA principles, the following stand out:

I – government action to maintain the ecological balance, considering the environment as a public asset to be necessarily ensured and protected, with a view to collective use; II – rationalization of the use of soil, subsoil, water and air; III – planning and inspection of the use of environmental resources (BRASIL, 1981, n/p).

The premises that guide the principles of the PNMA show its role as an instrument for the management of public infrastructure in an urban area and natural resources.

As a basic sanitation management instrument, the National Basic Sanitation Plan (Plansab) was created from Decree No. 8,141/2013 and Interministerial Ordinance No. 571/2013, this mechanism is in line with Law No. 11.445/ 2007 of National Guidelines for Basic Sanitation (LDNSB).

Regarding the definition of basic sanitation, it is important to consider the Plansab approach, which is based on Law No. 11.445/2007, with sanitation being "the set of services, infrastructures and operational facilities" consisting of (1) drinking water supply; (2) sanitary sewage; (3) urban cleaning and solid waste management, (4) rainwater drainage and management, cleaning and preventive inspection of the respective urban networks (BRASIL, 2007).

In the scope of sanitary sewage are the "activities, infrastructures and operational installations for the collection, transport, treatment and adequate final disposal of sanitary sewage, from the building connections to its final release into the environment" (BRASIL, 2016, n/p).

For the management of public infrastructure in an urban area, the conditions of the water supply system must be observed, understood as the set of infrastructure, equipment and services aimed at the adequate supply of water to communities and multiple uses (TSUTIYA, 2006).

It is noteworthy that the water supply in large urban centers is also influenced by factors such as: land use and occupation, high population density and economic activities. However, the impacts generated by environmental degradation influence the quality of water and the supply of large urban centers (TUNDISI; MATSUMURA-TUNDISI, 2020).

Improvements in sanitary conditions involve, for example, the design of collecting networks to avoid the contamination of rainwater. In Brazil, uncollected sewage receives various destinations, from sending it to septic tanks to discharging it into rainwater, disposing it into soil or bodies of water. When done correctly, the septic tanks provide quality of life and minimize impacts on the environment. Furthermore, sewage collection and treatment aim to reduce the levels of organic matter, pathogenic microorganisms and toxic waste (ANA, 2017; TONETTI et al., 2018).

It is required to think about these issues in a recurrent time of scarcity of water resources. Tundisi and Matsumura-Tundisi (2020) problematize water governance, warning that it must be able to promote a framework that integrates the water policy with its formulation processes. For this reason, water governance and sustainability must be integrated and based on the principles of “effectiveness, efficiency, equity, coherence, transparency and public participation” (TUNDISI; MATSUMURA-TUNDISI, 2020, p. 107).

Thus, sanitation must be considered as an integral part of city planning, being able to identify and understand physical, chemical and biological aspects and land use and occupation, as well as technical aspects, in order to make planning part of the culture of the development (BRASIL, 2011; OLIVEIRA JÚNIOR, 2013).

In line with the evolution of sanitation in Brazil, there were numerous factors that hampered its consistent advance. The conditioning facts were not treated in associated ways, resulting in lack of planning, in addition to insufficient investments, inefficiency of sanitation service companies that have low technical quality and low investment (DÍAZ; NUNES, 2020).

Thus, the challenges that the PNSB faces must be addressed in an integrated manner in the context of human rights, environment, health and integrated management of public policies. Thus, the path taken with the construction and implementation of the PNSB, PNMA, National Water Resources Policy (PNRH) and Plansab follow similar trajectories (IPEA, 2020).

In the scope of urban rainwater drainage and management, the Guide for the elaboration of Municipal Basic Sanitation Plans (BRASIL, 2011) considers the "activities, infrastructures and operational installations of urban rainwater drainage, transport, detention or retention for the dampening flood flows, treatment and final disposal of drained rainwater in urban areas (BRASIL, 2011, p. 35).

For city planning, drainage management according to art. 70 of Law nº 189 of January 8, 2018 must consider:

a) elimination or mitigation of inundation points and floods, with priority given to points that affect the Structural Mobility Network; b) preventing the emergence of new inundation points and floods; c) compliance with art. 42-A of Federal Law No. 10,257, of 2001, in particular items IV and VI, for areas at risk of natural disasters, as per annexes XX and XXI of this Master Plan; d) maintenance of updated information on inundation and floods points in the Municipal Georeferenced Information System (BRASIL, 2018, n/p).

In order to comply with the provisions of Law No. 189 of 2018, the drainage system for planning cities depends on historical information on hydrological events and on the characteristics of the territory. The National Sanitation Secretariat (SNS) of the Ministry of Regional Development (MDR), prepared the 4th diagnosis of drainage and management of urban rainwater for the year 2019, with information provided by the municipalities. The diagnosis contains data on torrents, floodings, inundations and floods that are hydrological events with specific characteristics.

To deal with hydrological events, the SNIS adopts the following definitions from the Glossary of Civil Defense, Risk Studies and Disaster Medicine (CASTRO, 1998):

Torrent – Volume of water that drains on the surface of the land, with great speed, resulting from heavy rains.

Flooding – Water accumulated in the streets ways and in the urban perimeter due to heavy rainfall, in cities with deficient drainage systems.

Inundation- overflow of water from the normal gutter of rivers, seas, lakes and dams, or accumulation of water due to poor drainage, in areas not normally submerged.

Flood - Raising the water level of a river above its normal flow. Term commonly used as a synonym for flood (CASTRO, 1998, p. 13-97).

Another point to be highlighted in relation to the factors that affect the drainage system in cities refer to externalities. From this perspective, the 4th Diagnosis of urban rainwater drainage and management (SNIS, 2019) emphasizes the need for information on climate, topography, soil impermeabilization, geology, rainfall regime, water bodies regime, among others. On the other hand, it recognizes the limitation for monitoring and predicting the behavior of these externalities. It is also argued that climate change and unplanned or inadequately planned urban occupation affect the behavior of these variables, which may influence the expected performance of the drainage system.

In the case of inundations, according to Amaral and Ribeiro (2015, p. 41) the intensity and frequency depend “on the distribution of precipitation, the rate of water infiltration into the soil, the degree of soil saturation and the morphometric and morphological characteristics of the drainage basin”. In addition, under natural conditions "the plains and bottoms of narrow valleys present slow surface runoff of rainwater, and in urban areas these phenomena have been intensified by anthropogenic alterations, such as the soil impermeabilization".

It is important to emphasize that in the process of resignification of the occupation and re-urbanization of urban areas, the management of infrastructure and installation of rainwater drainage networks must be aligned with the Master Plan of the cities, located and contextualized according to the conditions of the territory.

URBAN DRAINAGE IN THE CITY OF CAMPINAS

Due to the high population density in vulnerable areas, large urban centers, such as Campinas, have been responsible for several environmental problems, especially with flooding, as pointed out by Marques, Silva and Camargo (2017).

The municipality of Campinas has a subtropical climate of dry winter and hot summer, an area of approximately 795 Square Kilometers, with two morphostructural units - one with smooth relief, composed of hills, plains and river terraces; and another with topography composed of hills and small hills (MARQUES; SILVA; CAMARGO, 2017). As for precipitation in the city of Campinas, CEPAGRI (2021) highlights that the annual average for the city in the period from 1990 to 2020 was 1,404.2 mm.

According to the 2017 Campinas Strategic Master Plan (PREFEITURA DE CAMPINAS, 2017), the municipality of Campinas has an extensive macro-drainage network, and there are water courses in all regions. The city's main water resources are: the Atibaia River, the Jaguari River, the Capivari and Capivari Mirim Rivers and the Ribeirão Quilombo resurgence. The municipality has more than 160 secondary water courses that flow into one of the aforementioned rivers, responsible for the city's runoff. Among the main water courses, the following stand out: the Anhumas and Cabras streams, and the Piçarrão, Tanquinho and Viracopos streams.

At the Metropolitan Region of Campinas (MRC), technical works were prepared to discuss the guidelines of the Integrated Urban Development Plan (PDUI) for the region, based

on the contract signed between the Metropolitan Agency of Campinas (Agemcamp) and the São Paulo Metropolitan Planning Company S/A (Emplasa). From this cooperation, a preliminary booklet of proposals was launched with guidelines for the territorial ordering and development of the MRC.

With regard to urban drainage, it was proposed to promote the “drainage and soil permeability actions, through green areas, to allow more controlled flow of floods” (PDUI, 2018, p. 55).

To meet the guidelines proposed in the PDUI, the MRC depends on a network of integrated and geo-referenced territorial information. The system must provide information to meet the “parks and green areas system, consisting of the set of water courses, drainage headwaters and alluvial plains, urban parks, linear and natural, significant green areas and protected areas and open spaces” (PDUI, 2018, p. 76).

According to Ignácio (2020, p. 42), “rainwater is divided into two segments: one that infiltrates the soil and forms the groundwater and another that runs off on the surface, originating the underground and surface watersheds”.

Ignácio (2020) in his research carried out on drainage in the city of Campinas concluded that the problems due to floods, inundations and floodings have been seen as a consequence of the disorderly growth of the municipality with indiscriminate occupations, in addition to the lack of planning with the use of an obsolete drainage system. According to Claro and Deantoni (2017), in 2016 there were ten flooding points in the city and ten critical points susceptible to floods and inundations.

From the data available in the 2015 SNIS notebooks, 2017, 2018 and 2019, it is observed that since 2015 the municipality has had hydrological risk warning systems (floods, floods and floods), as well as carrying out comprehensive mapping of areas of risk of flooding of urban watercourses.

The city of Campinas monitors the following hydrological data: (a) amount of rainfall by automatic recording; (b) water level in watercourses by telemetry; (c) amount of rainfall per daily sampling frequency; (d) amount of rain by telemetry.

In 2019, the total population of the city of Campinas corresponded to 1,204,073 inhabitants, among which, approximately 98.3% lived in urban areas, with a demographic density of 2,520 inhab/km² (IBGE, 2011). In 2019, 0.1% of the population was impacted by hydrological events (SNIS, 2019).

Ignácio (2020) highlights that in the city of Campinas, problems related to floods are also subject to an obsolete drainage system, and regardless of the social level of the population where they live, there is a record of occurrence of floods, such that the entire population is at risk. Thus, it is essential to prepare a Master Plan for Urban Drainage, so that the City Hall makes viable the actions and proposals to remedy the problems associated with flooding, especially for the city of Campinas, a large city, with high degree of urbanization, which presents a series of problems associated with flooding. It is noteworthy that the treatment and retention of rainwater contributes to reducing the consumption of drinking water, in addition to helping to control inundations.

Table 1 shows data on the risks of inundations, torrents and floodings, for the period from 2015 to 2019, not registered in S2ID, which is part of the National Secretariat for Civil Defense and Protection (SEDEC). It is worth noting that for the year 2016 the National Sanitation Secretariat did not provide the annual rainwater diagnosis

Table 1: Number of households in Campinas subject to risk of inundations, torrents or floodings

| Period | Quantity of de Households subjected to inundations risk | Quantity of inundations registered at S2ID | Quantity of not torrents registered at S2ID | Quantity of not floodings registered at S2ID | Quantity of inundations, torrents and floodings not registered at S2ID |
|--------|---|--|---|--|--|
| 2015 | 315 | 04 | 38 | 432 | 474 |
| 2017 | 8.285 | 09 | 14 | 179 | 202 |
| 2018 | 8.285 | 02 | 19 | 88 | 109 |
| 2019 | 8.285 | 02 | 24 | 122 | 148 |
| Total | | 25 | 95 | 821 | 933 |

Source: Prepared from SNIS data.

The data in Table 1 allow us to observe that the mapping of risk areas in the city of Campinas in relation to inundations, torrents and floodings had a small reduction in the year 2019 compared to 2015. However, the occurrences of flooding are still events impacting this municipality.

Despite the low number of households at risk of inundations, torrents or floodings in Campinas, the PDUI prepared by the Municipality of Campinas (2018, p. 106) created a guideline to “decrease the occupation of areas with geological-geotechnical risks of flooding and on contaminated soils, prioritizing watershed territories” and for “preventing the emergence of new situations of vulnerability and a housing resettlement policy”.

As a measure to manage the occurrence of floods and inundations resulting from changes in the characteristics of the territory, the following were proposed: (a) definition of criteria for the use and occupation of the land; (b) definition of strategies to expand green areas; (c) improvement of existing drainage systems and support for other forms of rainwater capture (PDUI, 2018, p. 172).

In relation to population densification that affects water resources without adequate sewage collection and treatment, impairing water quality and availability of surface water, the guideline is to “preserve and restore water spring areas, from the perspectives of quality and availability of the watershed and monitoring of land use and occupation, so as not to compromise water security in the MRC” (PDUI, 2018, p. 147).

CONCLUSION

The municipality of Campinas/SP has suffered from problems related to surface water runoff, a consequence of the high degree of urban density and the increase in impermeable areas. As a result, the municipality has changed the demand from the hydrographic basin and the degree of the soil impermeabilization, thus intensifying flood events.

In order to act with corrective and preventive measures, it is essential to prepare a Master Plan for Urban Drainage in order to better understand the use of the land and the hydrographic basins that operate in the municipality. The municipality of Campinas has an Integrated Urban Development Plan which, among the various guidelines, some of which consist of reducing the risk of torrents and inundations based on criteria for land use and occupation, the expansion of green areas, improvement of drainage systems, among others.

Although the actions to monitor hydrological events are a reality in the city of Campinas/SP, the measures implemented are still not sufficient to diagnose the occurrence of flooding in advance. In this sense, the adequacy of the infrastructure conditions of the drainage

system is suggested to face the external factors that constitute an important obstruction in the configuration of the urbanization of the territory.

BIBLIOGRAPHICAL REFERENCES

ANA. AGÊNCIA NACIONAL DE ÁGUAS. **Atlas esgotos**: despoluição de bacias hidrográficas / Agência Nacional de Águas, Secretaria Nacional de Saneamento Ambiental. Brasília: ANA, 2017. 88p.

_____. **Panorama do Saneamento no Brasil**. 2020. Available at: <<https://www.gov.br/ana/pt-br/assuntos/saneamento-basico/a-ana-e-o-saneamento/panorama-do-saneamento-no-brasil-1>>. Access: 13 mai. 2021.

AMARAL, R. do; RIBEIRO, R. R. **Inundações e Enchentes**. In: TOMINAGA, L. K.; SANTORO, J.; AMARAL, R. do. Desastres naturais: conhecer para prevenir. São Paulo: Instituto Geológico, 2015.

BRASIL. Ministério das Cidades. **Guia para a elaboração de Planos Municipais de Saneamento Básico**. 2. ed. Brasília: Ministério das Cidades, 2011.

BRASIL. **Lei nº 11.445, de 5 de janeiro de 2007**. Estabelece as diretrizes nacionais para o saneamento básico; cria o Comitê Interministerial de Saneamento Básico; altera as Leis nos 6.766, de 19 de dezembro de 1979, 8.666, de 21 de junho de 1993, e 8.987, de 13 de fevereiro de 1995; e revoga a Lei nº 6.528, de 11 de maio de 1978. (Redação pela Lei nº 14.026, de 2020). Diário Oficial da União, Brasília, 08 jan. 2007. Available at: <http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/lei/l11445.htm>. Access: 08 out. 2021.

BRASIL. Ministério das Cidades. **Guia para a elaboração de Planos Municipais de Saneamento Básico**. Brasília: Ministério das Cidades, 2011.

BRASIL. **Lei nº 13.308, de 6 de julho de 2016**. Altera a Lei nº 11.445, de 5 de janeiro de 2007, que estabelece diretrizes nacionais para o saneamento básico, determinando a manutenção preventiva das redes de drenagem pluvial. Diário Oficial da União, Brasília, 07 jul. 2016. Available at: <http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2016/lei/l13308.htm>. Access: 08 out. 2021.

BRASIL. **Lei nº 189, de 08 de janeiro de 2018**. Prefeitura Municipal de Campinas. Dispõe sobre o Plano Diretor Estratégico do município de Campinas. Campinas: Diário Oficial do Município. Available at: <https://suplementos.campinas.sp.gov.br/admin/download/suplemento_2018-01-09_cod473_1.pdf>. Access: 07 out. 2021.

CASTRO, A. L. C de. **Glossário de defesa civil estudos de riscos e medicina de desastres**. Brasília, DF: Ministério do Planejamento e Orçamento. Secretaria Especial de Políticas Regionais, Departamento de Defesa Civil, 2. ed., 1998.

CEPAGRI. **Climatologia Campinas**. Available at: <<https://www.cpa.unicamp.br/graficos>>. Access: 09 out. 2021.

CLARO, P. C. T; DEANTONI, V. B. Avaliação da ocupação do solo na bacia do Ribeirão Anhumas: uma análise com foco na drenagem urbana. **Anais do XXII SBRH – Associação Brasileira de Recursos Hídricos**, Florianópolis, 2017.

DÍAZ, R. R. L.; NUNES, L. R. A evolução do saneamento básico na história e o debate de sua privatização no Brasil. **Revista de Direito da Faculdade Guanambi**, v. 7, n. 2, p. 1-23, 2020.

FERREIRA, P. F. M. **Diagnóstico dos impactos socioambientais urbanos em Itacaré- BA**. 2011, 159 f. Dissertação (Mestrado) - Instituto de Geociências, Universidade Estadual de Campinas (UNICAMP), Campinas, 2011.

IBGE. **Censo Demográfico 2010**. Resultados do universo por setores censitários, 2011. Available at: <<https://censo2010.ibge.gov.br/resultados.html>>. Access: 09 out. 2021.

IGNÁCIO, C. F. **Considerações sobre a drenagem urbana**: o caso das inundações em Campinas (2016-2018). 2020, 115 f. Dissertação (Mestrado) - Faculdade de Arquitetura e Urbanismo, Pontifícia Universidade Católica de Campinas, Campinas, 2020.

IPEA. INSTITUTO DE PESQUISA ECONÔMICA APLICADA. **Nota técnica do IPEA**: Apontamentos sobre a dimensão territorial da pandemia da COVID-19 e os fatores que contribuem para aumentar a vulnerabilidade socioespacial nas unidades de desenvolvimento humano de áreas metropolitanas brasileiras. 2020. 59p. Available at:

<https://www.ipea.gov.br/portal/index.php?option=com_content&view=article&id=35497&catid=3&Itemid=3>.
Access: 29 ago. 2021.

MARQUES, M. L.; SILVA, M. C. da; CAMARGO, D. M. de. Análise Espacial da Vulnerabilidade Socioambiental no Município de Campinas. Análise Espacial da Vulnerabilidade Socioambiental no Município de Campinas. **Revista Brasileira de Cartografia**, v. 69, n. 9, p. 1857-1870, 2017.

OLIVEIRA JÚNIOR, J. L. **Tratamento descentralizado de águas residuárias domésticas**: uma estratégia de inclusão social. In: LIRA, W. S.; CÂNDIDO, G. A. Gestão sustentável dos recursos naturais: uma abordagem participativa. Campina Grande: EDUEPB, 2013.

PDUI. PLANO DE DESENVOLVIMENTO URBANO INTEGRADO. Região Metropolitana de Campinas. **Relatório IV. Caderno Preliminar de propostas**, 2018. Available at: <https://www.pdui.sp.gov.br/rmc/?page_id=755>. Access: 08 out. 2021.

PREFEITURA DE CAMPINAS. **Plano Diretor Estratégico** – Caderno de Subsídios, 2017. Available at: <https://planodiretor.campinas.sp.gov.br/timeline/timeline/41_nova_versao_caderno_subsidios_janeiro_17/Caderno_com_anexos.pdf>. Access: 09 out. 2021.

RICHARDSON, R. J. **Pesquisa social**: métodos e técnicas. São Paulo: Atlas, 1999.

SMDU. SECRETARIA MUNICIPAL DE DESENVOLVIMENTO URBANO. **Manual de drenagem e manejo de águas pluviais**: Gerenciamento do sistema de drenagem urbana. São Paulo: SMDU, 2012.

SNIS. SISTEMA NACIONAL DE INFORMAÇÕES SOBRE SANEAMENTO. **4º Diagnóstico de Drenagem e Manejo das Águas Pluviais Urbanas**. Brasília: SNS/MDR, 2019. Available at: <<http://snis.gov.br/diagnostico-anual-aguas-pluviais/diagnostico-do-servico-de-aguas-pluviais-2019>>. Access: 07 out. 2021.

_____. SISTEMA NACIONAL DE INFORMAÇÕES SOBRE SANEAMENTO. **Diagnóstico das águas pluviais**. Brasília: SNS/MDR. Available at: <<http://snis.gov.br/diagnostico-anual-aguas-pluviais>>. Access: 07 out. 2021.

TONETTI, A. L. et al. **Tratamento de esgotos domésticos em comunidades isoladas**: referencial para a escolha de soluções. Campinas: Biblioteca/Unicamp, 2018.

TSUTIYA, M. T. **Abastecimento de Água**. São Paulo: Departamento de Engenharia Hidráulica e Sanitária da Escola Politécnica da Universidade de São Paulo, 2006.

TUNDISI, J.G.; MATSUMURA-TUNDISI, T. **A Água**. São Carlos: Scienza, 2020.