

The Covid-19 pandemic and regional particularities of its diffusion in the urban network segment in the state of Tocantins, Brazil

La pandemia de Covid-19 y las particularidades regionales de su difusión en el segmento de red urbana en el estado de Tocantins, Brasil

A pandemia de Covid-19 e as particularidades regionais da sua difusão no segmento de rede urbana no estado do Tocantins, Brasil

Kelly Bessa

Universidade Federal do Tocantins (UFT)
kellybessa@uft.edu.br

Rodolfo Alves da Luz

Universidade Federal do Tocantins (UFT)
rodolfodaluz@mail.uft.edu.br

Abstract

This paper presents contributions on the spatial diffusion of Covid-19 in the state of Tocantins, considering the spatial interactions of the main regional, sub-regional and micro-regional centers, as well as the regional particularities of this urban network. It was pointed out a complex geographical position in the North Center region of Brazil, with spatial articulations among regions, locations, cities and people, which facilitate the spread of the pandemic, not only through hierarchical interactions, but also through complementary interactions. Such interactions reveal two dispersion patterns, a vertical one and a horizontal one, which resulted in spatial configurations that combine nodes, axes and areas, which place Tocantins in a critical epidemiological situation.

Keywords: Covid-19, spatial interactions, urban network, Tocantins, Brazil.

Resumen

Este artículo presenta contribuciones sobre la difusión espacial de Covid-19 en el estado de Tocantins, considerando las interacciones espaciales de los principales centros regionales, subregionales y microrregionales, así como las particularidades regionales de esta red urbana. Se señaló una posición geográfica compleja en la región

Centro Norte de Brasil, con articulaciones espaciales entre regiones, ubicaciones, ciudades y personas, que facilitan la propagación de la pandemia, no solo a través de interacciones jerárquicas, sino también a través de interacciones complementarias. Estos revelan dos patrones de dispersión, uno vertical y otro horizontal, que dieron como resultado configuraciones espaciales que combinan nodos, ejes y áreas, que colocan a Tocantins en una situación epidemiológica crítica.

Palabras clave: Covid-19, interacciones espaciales, red urbana, Tocantins, Brasil.

Resumo

O presente artigo, de maneira exploratória, apresenta contribuições sobre a difusão espacial da Covid-19 no estado do Tocantins, considerando as interações espaciais dos principais centros de influência regional, sub-regional e microrregional, bem como as particularidades regionais desse segmento de rede urbana. Essas particularidades apontam para uma posição geográfica relacional complexa na porção centro-norte brasileira, com articulações espaciais densas, entre regiões, lugares, cidades e pessoas, que facilitam a propagação da pandemia, não apenas por meio das interações hierárquicas, mas também por meio das complementares. Tais interações revelam dois padrões de dispersão, um vertical e outro horizontal, que resultaram em configurações espaciais que combinam nós, eixos e áreas, colocando o Tocantins em situação epidemiológica crítica.

Palavras-chave: Covid-19, interações espaciais, rede urbana, Tocantins, Brasil.

Introduction

As pointed out in some studies, the propagation of Covid-19 and the controlling measures have very evident spatial aspects. To Haesbaert (2020, p. 5), “the Covid-19 pandemic and its fight have a clear and relevant geographic dimension”.

Such dimension, as Sposito and Guimarães (2020, n.p.) indicate, has become evident because “the data over the spread of the disease in the country show that it’s about a hierarchical model, strongly related to the existing spatial interactions in the Brazilian urban network. Corrêa (2001, p.93) teaches that this network, through the “[...] spatialized social interactions, articulate all society in a given space portion, assuring its existence and reproduction”, being “considered as a synthesis, of most if not all, many and many geographic networks which knots and specific fluxes begin, end or go through the cities (CORRÊA, 2012, p.204). In these last ones, live most of the Brazilian population, which makes a constant use of overlapped networks, especially the communication and informational ones, the transportation ones, which generate aerial, highway, railway, hydro way connections, and the like.

The spatial displacement of the population to obtain goods and services, mainly in an urban center, and the complex circulation responsible for the existence and provision of these services of urban nature, which generate exchanges geographically near and distant ones, start being relevant in the diffusion of the Covid-19 pandemic. This complex

¹ Disease, thus denominated by the World Health Organization (WHO), caused by a new type of coronavirus (SARS-CoV-2), which first notification occurred in the city of Wuhan, in China, in December 2019, and the pandemic situation was declared in March 11th 2020 (WHO, 2020).

spatial mobility, which involves “the circulation and connectivity among different places” (SPOSITO; GUIMARÃES, 2020, n.p.), and, specifically, between different centers, of different segments of urban network, it’s the one which interests the most “[...] to understand the virus spread”, as indicated by Sposito and Guimarães (2020, n.p.). The latter, allied to the acknowledgment of an extensive urbanization of the territory, with the conformation of an urban network equally extensive, which covers the territory with a geographic thickness that reveals itself through spatial, complementary and hierarchical nexus, established among the most distinct urban centers (SANTOS, 1993; CORRÊA, 2012).

In Brazil, the first case of Covid-19 was registered on February 26th 2020 in the city of São Paulo, two months later China sent out a warning. Ever since, São Paulo has become the epicenter of the pandemic in the country, and the spatial spread of the disease was guided, mostly, due to the interurban relations, not only in this hinterland, but in the wide area of connections of this macrometropolis, reaching other metropolis (above all the ones that have international airports), urban agglomerations, intermediate centers and small towns in the state of São Paulo and in other Brazilian states. However, even though this movement occurs, mainly, “[...] according to the urban network and in accordance with its urban hierarchy” SPOSITO; GUIMARÃES, 2020, n.p.), it’s important to emphasize that it doesn’t guide itself only by hierarchy, but also by complementarity, which introduces particularities, above all in regional urban networks, for example the segment led by Palmas, the capital of the state of Tocantins, in the center-north portion of the country.

In this segment of regional urban network, even though it’s out of the “core area” or of the Brazilian “concentrated region” (CORRÊA, 1989; SANTOS, 1993), Palmas catches our attention for being the youngest capital, the newest Brazilian federative unit, by its geographic position related to the centers, the segment of network and of the state itself, as well as by the establishment of complex complementary and hierarchic articulations in regional scale and extraregional ones (national and international). These articulations are facilitated by the improvement in the infrastructural basis of transportation, which aim at securing the center-north exportation corridors, which implies in regular exchanges with urban centers of the regions Center-West, North and Northeast, emphasizing the ones with metropolitan hierarchy, especially Brasília, Goiânia, Belém and São Luís, and those ones with regional hierarchy, as Imperatriz and Marabá, and the like.

In these centers, the Covid-19 cases had their first registers on March 7th 2020 in Brasília, March 12th in Goiânia, March 18th in Belém, March 19th in São Luís, March 23rd in Marabá and March 26th 2020 in Imperatriz. In Palmas the first notification occurred on March 18th 2020 and, despite occurring in the same timeframe of this set of centers, the state of Tocantins, until recently, occupied the last position in the rank by cumulative number of cases. However, as the numbers of this pandemic change frequently and fast, it’s important to emphasize that Tocantins registered the biggest ratio among the rates detected in Brazilian states from April 19th 2020, when it presented the incidence of 21 cases of inhabitants per million and only 1 death, to May 19th 2020, when it’s passed

to register 1046.5 cases by millions of inhabitants and 33 deaths, an increase of 49.8 times of cases (FIOCRUZ, 2020).

Thus, it has become essential the understanding of the spread of Covid-19 in regional context, as an example of this one in Tocantins, exceptionally for being a newly created state, with one of the lower contributions to the national GDP, at about 0.5% of its total (IBGE, 2020d), and with 93% of its population depending on the Unified Health System, (hereby SUS), (SES-TO, 2019). All these aspects without taking into account its geographic position in one of the main articulation routes center-north of the country, which promotes interactions between regions, places, cities and people (IBGE, 2017b), making it easier the spread of Covid-19.

Therefore, this article analyses, in an exploratory way, the notification of the Covid-19 cases in the first three months of occurrence in the state of Tocantins, considering the understanding of the spatial dissemination from the urban centers of regional influence, sub-regional and micro-regional ones, as well as the local centers located in the basis of the urban network.

It's about a more empirical spatial analysis, set on the systematization of secondary data publically available, followed by a qualitative examination, as related to the evolution of the pandemic in Tocantins as to the analytical elements of the urban network, mainly hierarchy, geographic position and spatial interactions of the centers. The examination of the evolution of Covid-19 considered the 90 initial days of spread, since the first register, already mentioned, until June 16th 2020, according to the information of the epidemiologic newsletter available by the State Health Department (SES-TO), which receives such information from the municipalities and repasses it to the Ministry of Health with possible divergences and underreporting. It refers, therefore, to the official data, which consolidation was given until 5 p.m. of each day, when then it was released, but it has started being consolidated until midnight of each day, with its release only on the next day. Furthermore, information over the hospital assistance for the treatment of Covid-19 was used, also available by SES-TO. In the correlation of these information with the urban network, data of the population estimative for 2019 (IBGE, 2020a) were presented as well as the ones from the network pattern based on the studies of Cities Influence Regions – 2007 (IBGE, 2008, 2020b, 2020c), Territory Management (IBGE, 2014) and Regional Division of Brazil (IBGE, 2017a), with maps being elaborated, through the of a Geographic Information System with the software QGIS and PostgreSQL/PostGIS, charts, tables and graphics, which, together, allow to analyze the spread of Covid-19 in the state.²

The present article is subdivided into two items: the first one, shows some particularities of the segment of the urban network under the command of Palmas; in the second one, it presents the diffusion of Covid-19 in the territory of Tocantins state, stressing the main areas and routes of the dissemination.

² Huang, Liu and Ding (2020), Gattoa et al. (2020), Fortaleza et al. (2020), Monié (2020), Kraemer et al. (2020) are some of the authors of the many studies that are being performed in this perspective.

Particularities of a segment of regional urban network in the center-north portion of the country

The space of regional urban network is, by excellency, the one of contiguity. However, it's a reticulated space, marked by interactions in regional and extra regional scales, meaning that, by horizontal articulations, in the contiguity space, as well as by vertical articulations, in wide scales, as national ones as international ones. The latter ones perform themselves as a foundation to a complex geographic position which assures the insertion of distinguish urban centers in fluid networks of transportation, of communication ones, and the like. But, it's about a regional concrete space and, even that it presents vertical solidarities, hierarchical ones, it shows a life of relations that stablish itself due to the horizontal solidarities, more complementary ones (SANTOS, 1996). These latter ones are set around the centers which exert regional influences, sub-regional, microregional and, even, local center ones, which incapacity of offering goods and services is, usually, redressed by the geographic position along with these networks and by the spatial proximity with the centers that have a wider offer of urban functions.

With the settlement of the state of Tocantins, 60 new municipalities were created, including the one which was the capital state headquarters, which has joined the 79 already existing in the old North of Goiás. The state has, therefore, 139 municipalities. From the later ones, ten have a population equal or above 22.139 inhabitants – Palmas, Araguaína, Gurupi, Porto Nacional, Paraíso do Tocantins, Araguatins, Colinas do Tocantins, Guaraí, Tocantinópolis, Dianópolis. Together, they concentrated 51.7% of the state population (812.623 inhabitants), which, in 2019, according to the estimates of IBGE (2020a), had a total of 1.572.866 inhabitants. The other 129 municipalities with a populational size of until 18.440 inhabitants concentrated 48.3% of the state population (760.243 inhabitants) in this same year (Table 01). Although the urban concentration is an important data in this regional arrangement, it's necessary to register that it's about an urban profile marked by numerous small centers, where the urban functions don't meet the needs and demands of the local population.

Table 01: Tocantins: distribution of the municipalities by populational size range, 2019.

Populational size range	No. of municipalities	No. of inhabitants	% total
Until 18.440 inhab.	129	760.243	48.3%
Equal to or above 22.139 inhab.	10	812.623	51.7%
Total	139	1.572.866	100%

Source: IBGE (2020a).

Such centers are inserted, in the urban network, through regional centralities, like the ones of Palmas, that counts on with complex spatial interactions stablished in regional and extraregional scales; the ones of Araguaína, which exert a strong polarization of the north portion of the state, extending itself to south-west portions of Pará and south-southwest of Maranhão, where they impose themselves with the centralities of Marabá

and Imperatriz, respectively; and Gurupi, which performs a respectable regional polarization in the south portion of the state. Besides the sub-regional centralities, such as the ones from Porto Nacional, Paraíso do Tocantins, Araguatins and Dianópolis; and of microregional centralities, such as the ones of Colinas, Guaraí and Tocantinópolis. In the basis of this network segment, there's an expressive number of small centers, with local centralities, which are hierarchically subordinated to the centers of regional influence, the sub-regional ones and the microregional ones (IBGE, 2008, 2014, 2017a; BESSA, 2015, 2020).

These centralities are established by the actions of political, economic and social agents, indispensable to the development of the most hegemonic activities, especially the ones associated to the expansion of the agricultural frontier and to agribusiness, to the power plants and to the exportation corridors, as well as the ones connected to an offer of urban functions relevant to the supply of the local and regional demands of goods and services. These last ones increase the displacements to the health services (IBGE, 2020b), education and leisure, to the shopping in commercial establishments (IBGE, 2020c) and to other public and private services offered, with an emphasis to the transportation and financial ones. Soon, the centralities are the ones which structure a wide reticulated regional space, where it's possible to notice a complex spatial mobility, "drawing the attention to the compulsory accomplishment of ordinary tasks, even if the project isn't ordinary", as Santos points out (1996, p. 132).

So these displacements are fulfilled, it's important to highlight the improvements in the infrastructural basis, especially after the foundation of the state. Among those ones, are the construction and extension of the airport of Palmas, the construction and installation of the North-South Railroad and the improvements of the federal highways such as BR-153, BR-226, BR-010, BR-230, BR-235 and the state highways of intercity connecting state highways. The aerial connections are in a reticular wide space, in which are diversified and enlarged themselves to long distance interactions, notably in the points where there's a presence of airports with regular, namely, Palmas and Araguaína. On the other hand, the highway and railway connections are responsible for supporting as the short interactions as the long distance ones, with notorious densification in this center-north portion, which creates the conditions to spread the pandemic. Particularly, through these highway connections, a set of intercity connections has intensified and enlarged themselves, being possible to notice "[...] a life of relations in regional scale because the urban functions in other centers of this segment of network aren't able to supply the demands of their populations, which are in constant movement, overall in direction to Palmas" (BESSA, 2020, p. 9). But also towards Araguaína, in the north portion of the state, to Imperatriz, in the southwest of Maranhão, to Marabá, in the southeast of Pará, and, secondly, to Gurupi, in the south portion of Tocantins. There's, notoriously, a complementary and hierarchical solidarity plot among these cities, sometimes creating contiguities in the regional arrangement, sometimes associated with the vertical order in the supra-regional arrangement. This arrangement reinforces the conditions of spread of the pandemic. Furthermore, the population of the centers located in these highways have

a great part of their economic-urban relations associated to the highway movement itself, what exposes them to unfavorable conditions of the current sanitary situation.

In the majority of these centers which compose this urban network segment shows a functional dependency, which embraces the functions associated to health services, fundamental in this moment of expansion of the pandemic. Thus, it indicates that only Palmas, Araguaína and Gurupi offer high complexity services in public and private hospital assistance units. For the treatment of Covid-19, until June 11th 2020, those municipalities were the only ones which offered active ICU beds (46 beds), in addition to active beds of stabilization (4 beds) and clinical ones (45 beds). There're also public hospital assistance units, with incipient services of medium complexity, in Paraíso do Tocantins, Porto Nacional, Guaraí, Miracema do Tocantins, Alvorada, Dianópolis, Arapoema, Xambioá, Augustinópolis, Araguaçu, Pedro Afonso and Arraias, which has also become offering active beds of stabilization (5 beds) and clinical ones (104 beds) to Covid-19 treatment. Combined they totalized, until that data, nine active beds of stabilization, 149 clinical ones and 46 ICU ones to treat patients with Covid-19 (SES-TO, 2020a).

Therefore, it's a network segment defined by particularities guided by the recent foundation of this state territory and its capital, by its geographic position in one of the main circulation routes of the Brazilian center-north region, which creates overlapping spaces of the hinterlands of Palmas, Araguaína, Imperatriz and Marabá, and by the presence of numerous small-sized centers and by regional influence centers which offer urban functions beneath the necessary to handle a pandemic. As Harvey (2020, n.p.) stressed, it's clear that this population finds itself very "exposed and poorly prepared to face a crisis of public health in the scale of Coronavirus".

The spread of Covid-19 in the state of Tocantins

As mentioned, the first case of Covid-19 in Tocantins was notified on March 18th 2020, in Palmas, which is the main urban centrality in the state (Image 1). The clinical symptoms of this case manifested themselves after the return from a trip to Fortaleza, which registered the first case on March 16 th 2020. The beginning of the spread, obviously, happened through spatial interactions of long distance.

The measures aimed at preventing Covid-19 were initiated from March 13th 2020 (TOCANTINS, 2020a), before the register of this first case. After such notification, the state government declared, on March 21st 2020, "state of public calamity" and adopted social distancing measures to decrease the risk of contagion, which included restrictions to commercial activities and non-essential services, other preventive actions (TOCANTINS, 2020b). In the capital, these measures were more strictly adopted since March 19th 2020, one day after the confirmation of the first case (PALMAS, 2020a).

The first notification of Covid-19 in the state's interior happened on March 27th 2020, after nine days of the register in the capital, when a case in Araguaína was informed, which exerts the second main urban centrality in the state (Image 1 and Table 02). The

clinical symptoms of this case appeared after the return from a trip to the Brazilian coast, with passages by airports in São Paulo and Brasília. On that day, nine cases were registered in the state, eight in the capital and one in Araguaína, with an incidence of 0.57 cases per 100 thousand inhabitants, when Brazil's was of 1.63 cases (SES-TO, 2020c; MINISTÉRIO DA SAÚDE, 2020a).

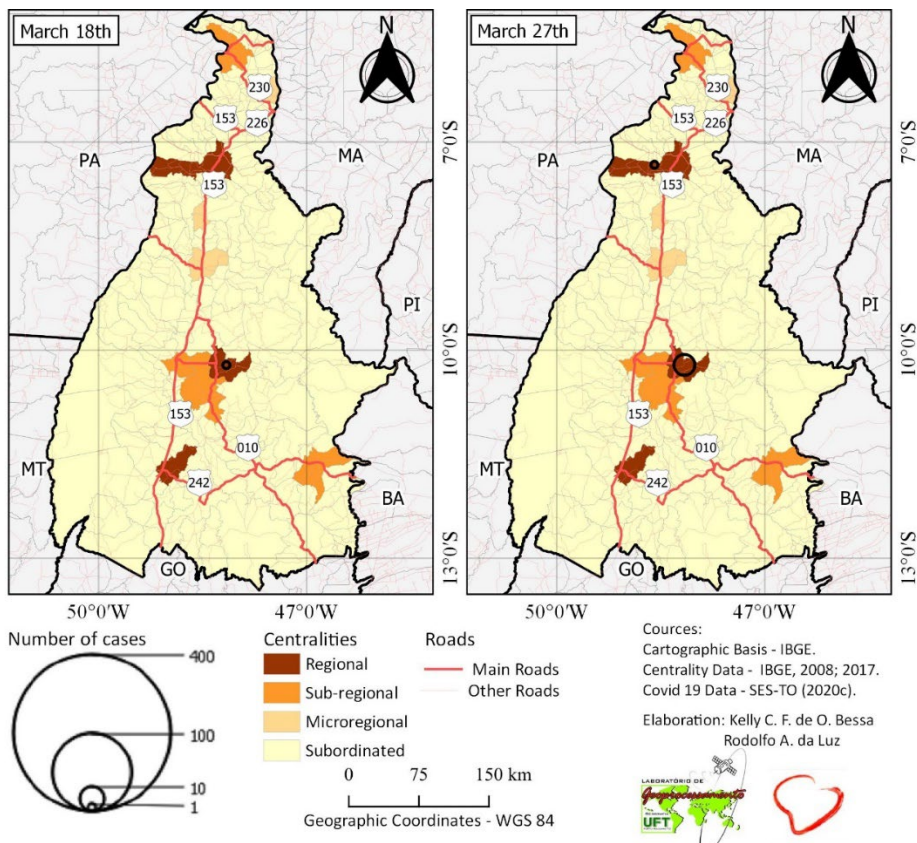


Image 01: Tocantins: urban centers of regional influence with confirmed and accumulated cases of Covid-19, on March 27th 2020.

Table 02: Tocantins: urban centers of regional influence with confirmed and accumulated cases of Covid-19, on March 27th 2020

Municipalities	No. of cases confirmed ¹	% total No. of cases	Confirmed rate per 100 thousand inhab.	No. of deaths	No. of days after the first register
Palmas	8	88.9	0.51	--	9
Araguaína	1	11.1	0.06	--	--
Tocantins Total	9	100	0.57	--	9

Source: SES-TO (2020c). Note: ¹ According to the municipality of domicile.

On April 8th 2020, after 21 days of the notification in the capital, the first case of Covid-19 in Gurupi was confirmed, which is the third main urban centrality of the state (Image 2 and Table 03). The clinical symptoms in this case manifested after the return from a trip to Goiânia. Such notification reinforces the internalization of the pandemic, which has started affecting the central portions, north and South of the state, corresponding to the three intermediate geographic regions, Palmas, Araguaína and Gurupi, defined based on the hierarchic classification of the centers of urban network (IBGE, 2017a). On that day, 23 accumulated cases were registered (an increase of 155.6% in relation to March 27th 2020), with the incidence of 1.46 cases per 100 thousand inhabitants, while Brazil's was of 7.63 cases (SES-TO, 2020c; MINISTÉRIO DA SAÚDE, 2020a).

These notifications of Covid-19 cases in Tocantins reveal that, initially, the spread of the pandemic follows a pattern of vertical dispersion, with spatial discontinuity, guiding itself through the hierarchy of the main urban centers and by the spatial vertical interactions accomplished by air, as in informed cases of trips to the cities of Fortaleza (CE), São Paulo (SP), Brasília (DF), Goiânia (GO), as well as to cities in Italy, Switzerland, France and England; and by road, due to the interstate exchanges, especially with the states of Goiás, Maranhão and Pará, besides Distrito Federal (SES-TO, 2020c).

Therefore, it's evident that the interstate and international circulation caused the entrance and initial spread of the Covid-19 pandemic in Tocantins. Thus, in the public control policies, it's fundamental the observation of the transmission resulting from a long distance geographic circulation, which connections were fulfilled in airports and main federal roads, which indicates the need of coordinated actions in national territory.

On April 13th, 30 days after the adoption of the initial prevention actions against Covid-19, the state government, considering the slow evolution of the pandemic in Tocantins, which on that date registered 26 accumulated cases, with the incidence of 1.65 cases per 100 thousand inhabitants, while Brazil had 11.23 cases (MINISTÉRIO DA SAÚDE, 2020a), the discrete pressure on health services and the absence of deaths, recommended the flexibilization of the prevention measures, including commercial activities and non-essential services, since protective measures were taken to avoid the contagion and assure the "selective social distancing" (TOCANTINS, 2020c, p. 1).

In Araguaína, the flexibilization has started being performed since March 26th 2020 (ARAGUAÍNA, 2020). In Palmas, the public power softened the opening to some non-essential economic activities from April 17th 2020 (PALMAS, 2020b). It's important to reinforce that the first death by Covid-19 occurred on April 14th 2020, in the capital (with a register in the epidemiologic newsletter of April 15th 2020) (SES-TO, 2020c).

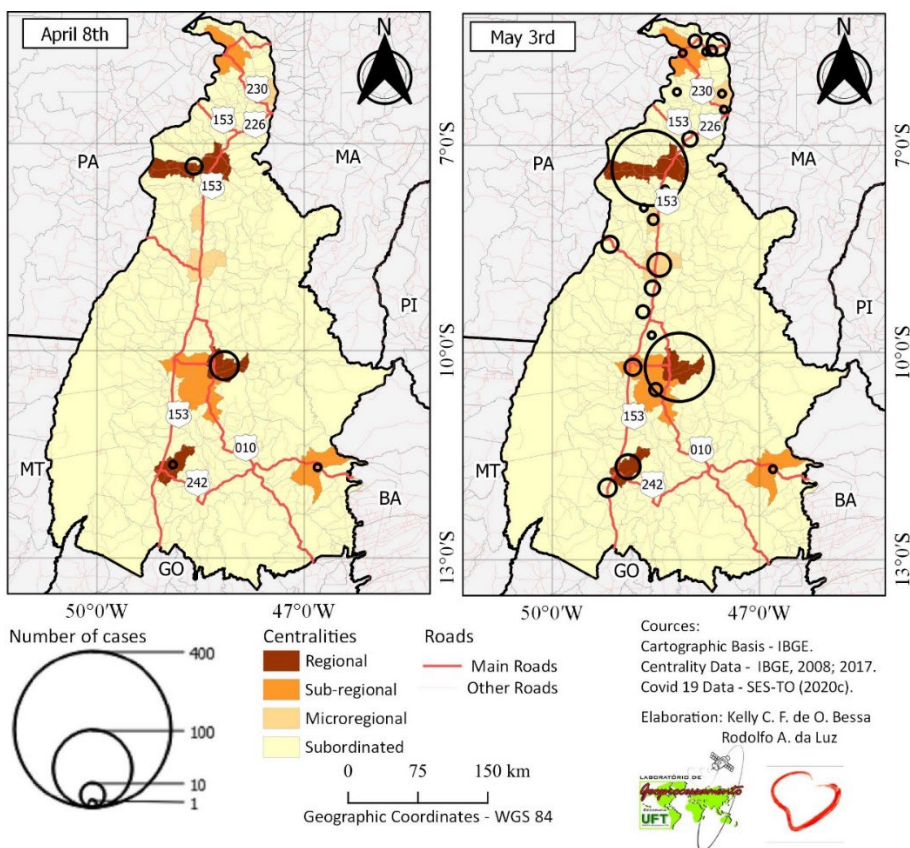


Image 02: Tocantins: urban centers of regional influence with confirmed and accumulated cases of Covid-19, on April 8th 2020.

Table 03: Tocantins: urban centers of regional influence with confirmed and accumulated cases of Covid-19, on April 8th 2020.

Municipalities	No. of confirmed cases ¹	% total No. of cases	Confirmed rate per 100 thousand inhab.	No. of deaths	No. of days after the first register
Palmas	15	65.2	0.95	--	21
Araguaína	6	26.1	0.38	--	12
Gurupi	1	4.3	0.06	--	--
Dianópolis ²	1	4.3	0.06	--	4
Total	23	100.0	1.46	--	21
Tocantins					

Source: SES-TO (2020c). Note: ¹ According to the municipality of domicile. ² This case was detected in Brasília, however the register came to the municipality of domicile on April 4th 2020, as oriented by the Ministry of Health.

Such flexibilization measures didn't take into account that the so called "communal transmission"³ has started in the state since April 12th 2020 (SES-TO, 2020b) and that the population from Tocantins was poorly prepared to the implementation of individual and collective measures of social distancing amid the functioning of economic activities. They also didn't consider the important role that the circulation of people has in the spread of the pandemic, such in the urban space of the cities as in the urban network, with the support of road connections. Furthermore, they've ignored the centralities that some cities perform in their areas of influence and the spatial interactions in wider areas, as Araguaína, for example, that, as mentioned before, performs a strong polarization in the north of the state, besides keeping regular exchanges with urban centers in the southeast of Pará and in the south-southwest of Maranhão, which incidences per 100 thousand inhabitants, on that date, were 3.13 and 6.28, respectively (MINISTÉRIO DA SAÚDE, 2020a).

In the other urban centers of sub-regional and microregional influence, the first Covid-19 cases were registered from April 15th to May 3rd 2020 (Image 2 and Chart 01) (SES-TO, 2020c). The internalization of the pandemic has started reaching the main centers, which became spaces for the spread of the virus in their respective regions, mainly through interurban relations, but with possibilities of reaching city-countryside interactions and city-village ones⁴. On May 3rd 2020, 267 accumulated cases of Covid-19 were registered in Tocantins (an increase of 1060.9% in relation to April 8th 2020) (Image 2 and Table 04), with the incidence of 16.98 cases per 100 thousand inhabitants, while Brazil's was of 48.17 cases. Moreover, 39 recovered cases were registered, 25 hospitalizations in public and private hospital units, the equivalent to 11.3% of total active cases of Covid-19, and six deaths, with a lethality rate of 2.2% (SES-TO, 2020c; MINISTÉRIO DA SAÚDE, 2020a).

Chart 01: Tocantins: urban centers of sub-regional and microregional influence with registered cases of Covid-19, from April 15th to May 3rd 2020.

Municipalities	Data of register of the first case in the municipality	No. of days after the register of the first case in the state
Tocantinópolis	April 15 th 2020	28
Guaraí	April 26 th 2020	39
Porto Nacional	April 28 th 2020	41
Paraíso do Tocantins	April 29 th 2020	42
Colinas do Tocantins	April 30 th 2020	43
Araguatins	May 3 rd 2020 ¹	46

Source: SES-TO (2020c). ¹ Registered in the epidemiological newsletter on May 4th 2020.

³ The Ministry of Health has declared state of communal transmission of Covid-19 in Brazil since March 20th 2020 (MINISTÉRIO DA SAÚDE, 2020b).

⁴ On June 18 2020, SES-TO informed that, since the beginning of the spread of the pandemic in the state, ten indigenous were diagnosed with Covid-19. These cases have been watched by the Special Indigenous Health District of Tocantins (DSEI-TO) (TOCANTINS..., 2020)

Table 04: Tocantins: urban centers of regional, sub-regional and microregional influence with confirmed cases of Covid-19, on May 3rd 2020

Municipalities	No. of confirmed cases ¹	% total No. of cases	Confirmed rate per 100 thousand inhab.	No. of deaths	No. of days after the first register
Palmas	87	32.6	5.53	2	46
Araguaína	104	39.0	6.61	--	38
Gurupi	11	4.1	0.70	--	26
Porto Nacional	3	1.1	0.19	--	6
Paraíso do Tocantins	5	1.9	0.32	1	23
Araguatins	1	0.4	0.06	--	--
Dianópolis	1	0.4	0.06	--	30
Colinas do Tocantins	2	0.7	0.13	--	5
Guaraí	10	3.7	0.64	--	8
Tocantinópolis	1	0.4	0.06	--	19
Subordinate Municipalities	42	15.7	2.67	3	23
Total Tocantins	267	100.0	16.98	6	46

Source: SES-TO (2020c). Note: ¹ According to the municipality of domicile and registered in the epidemiological newsletter on May 4th 2020.

Therefore, besides the pattern of vertical dispersion, a pattern of horizontal dispersion is added, with spatial contiguity, when the contagion happens in the interior of its own state and guided by geographically close exchanges, complementary ones, above all with the main centers of urban influence. Among those ones, it's important to emphasize Araguaína, which overcame the capital in number of cases on April 29th 2020 (SES-TO, 2020c), and Palmas, which are the ones that registered the highest number of Covid-19 cases (71.6% of the total, on May 3rd 2020. Besides Gurupi, Guaraí, Paraíso do Tocantins and Colinas do Tocantins, which, along Araguaína, are located at BR-153, and also Araguatins and Tocantinópolis, by their bordering geographic position with the municipalities of highly affected states (Pará and Maranhão, which incidences per 100 thousand inhabitants, on that date, were of 44.90 and 57.10, respectively) (MINISTÉRIO DA SAÚDE, 2020a).

With this pattern of horizontal dispersion, the Covid-19 reaches more promptly the small centers from Tocantins and it suggests a main dispersion route, formed on the road axes of BR-153, BR-226, BR-230 and BR-010, along with secondary dispersion routes, the access routes to the capital and to Araguaína, for example, and also the ones that establish connections with the bordering municipalities of other states, especially the ones from Maranhão and Pará. These ones have become the main spreading routes of the pandemic in Tocantins. Finally, it's a spatial configuration that combines knots, routes and interconnected areas (Image 3).

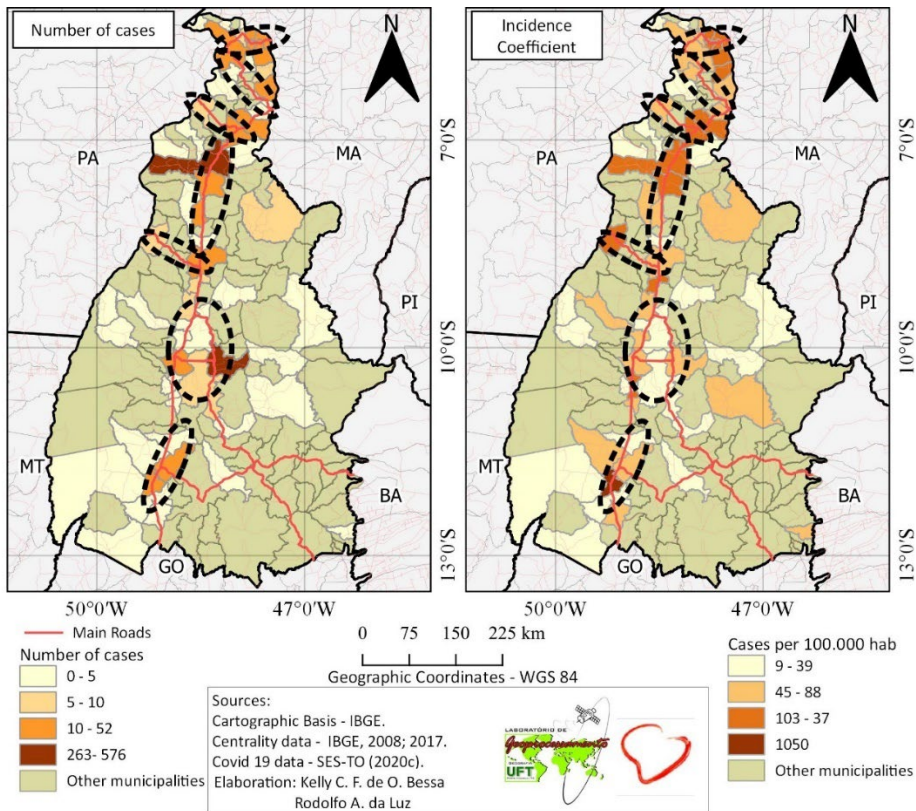


Image 03: Tocantins: axes and areas in the process of diffusion of Covid-19, according to the number and coefficient of incidence per 100 thousand inhabitants of notified and accumulated cases on May 17th 2020.

Thus, in the public policies to face the pandemic, it's become essential to watch the transmission resulting from this circulation on federal and state roads which cross the territory of Tocantins, especially in the access points and the ones of intersection with interstate limits, with urban centers and with the indigenous communities and villages, what reinforces the need of coordinated control policies in the national territory, but focusing on regional particularities.

With the convergence of these two dispersion patterns, there's a faster dissemination and, especially, a more widespread one of Covid-19 in Tocantins. The data on May 17th 2020, when the first register in the capital completed 60 days, revealed an explosion in the number of cases in Tocantins (Image 4 and Table 05). On that date, there were 1.496 accumulated cases of Covid-19 in the state (an increase of 460.3% in relation to May 3rd 2020), with the incidence of 95.11 cases per 100 thousand inhabitants, while Brazil's was of 114.72 cases. There was a register of 269 recovered cases, 93

hospitalizations, with patients who lived in the state and others who didn't⁵, in public and private hospital units, about 7.8% from the total of active cases of Covid-19, and 32 deaths (an increase of 433.3% in relation to May 3rd 2020), with a lethality rate of 2.1%. It raises our awareness that the intermediate geographic region of Araguaína outweighs the Brazilian incidence coefficient, with 145.08 cases per 100 thousand inhabitants, following the incidences in Pará and Maranhão, respectively, 161.16 and 176.56 cases. Besides counting 68.8% of deaths (28.1% in Palmas' and 3.1% in Gurupi's region) (SES-TO, 2020c; MINISTÉRIO DA SAÚDE, 2020a).

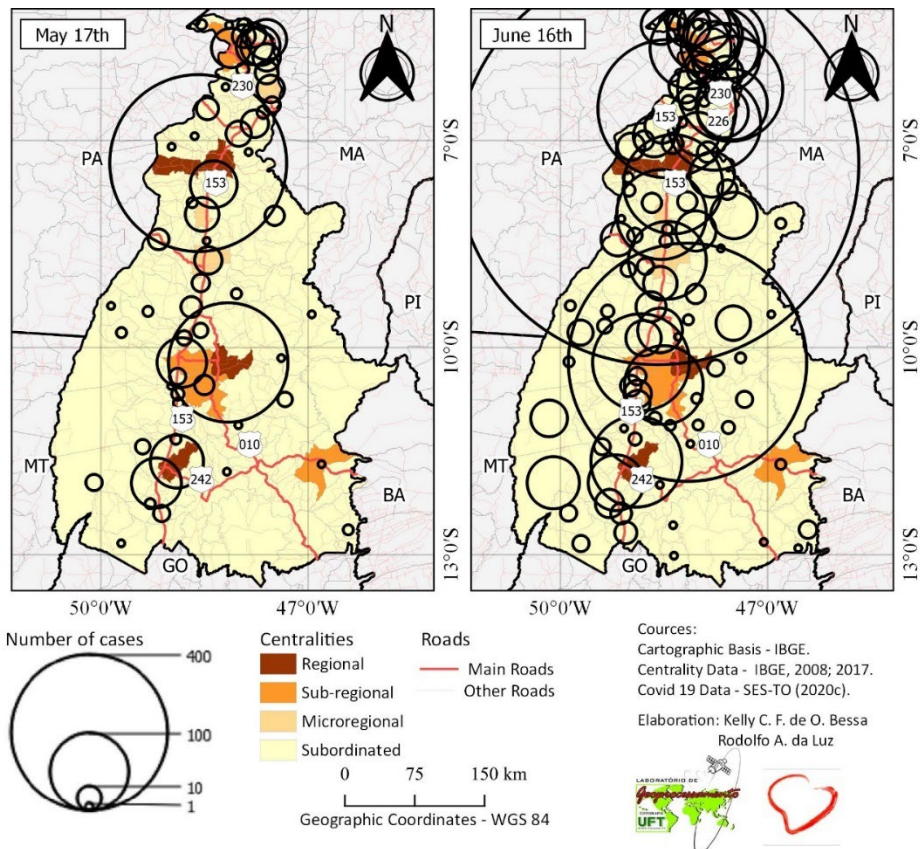


Image 04: Tocantins: urban centers of regional, sub-regional and microregional influence with confirmed cases of Covid-19, on May 17th 2020.

⁵ There are hospitalizations from the southeast of Pará in private hospitals of Palmas and of transportation professionals of cargo transport (truck drivers) from other states. (PATIENTS..., 2020; SES-TO, 2020c).

Table 05: Tocantins: urban centers of regional, sub-regional and microregional influence with confirmed cases of Covid-19, on May 17th 2020.

Municipalities	No. of confirmed cases ¹	% total No. of cases	Confirmed rate per 100 thousand inhab.	No. of deaths	No. of days after the first register
Palmas	300	20.1	19.07	3	60
Araguaína	631	42.2	40.12	7	51
Gurupi	53	3.5	3.37	1	40
Porto Nacional	7	0.5	0.45	1	19
Paraíso do Tocantins	45	3.0	2.86	3	36
Dianópolis	1	0.1	0.06	--	30
Araguatins	30	2.0	1.91	4	3
Guaraí	17	1.1	1.08	1	21
Colinas do Tocantins	23	1.5	1.46	--	17
Tocantinópolis	14	0.9	0.89	1	32
Subordinate Municipalities	375	25.1	23.84	11	36
Total Tocantins	1.496	100.0	95.11	32	60

Source: SES-TO (2020c). Note: ¹ According to the municipality of domicile and registered in the epidemiological newsletter on May 18th 2020.

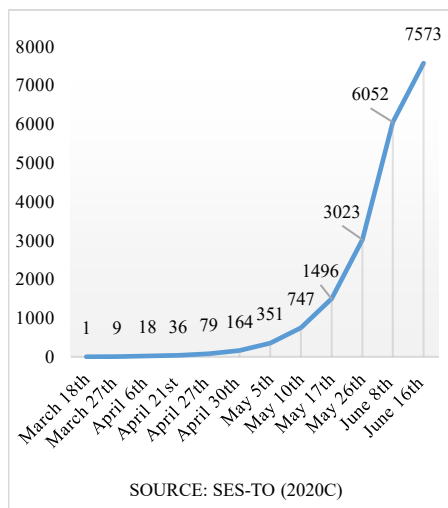


Image 05: Evolution in the number of accumulated cases of Covid-19 in Tocantins, from March 18th to June 16th 2020.

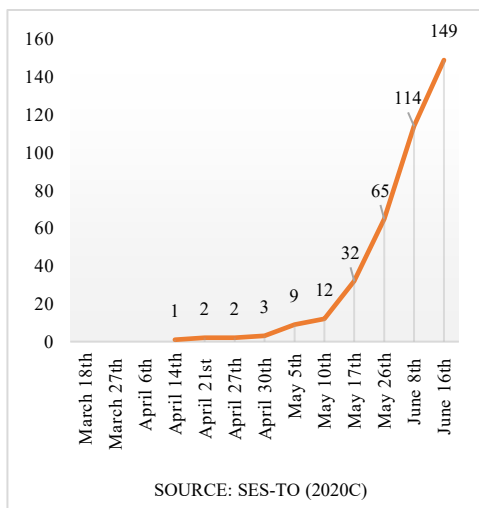


Image 06: Evolution in the number of accumulated deaths by Covid-19 in Tocantins, from March 18th to June 16th 2020.

The evolution of the date shows that the accumulated number of cases has doubled faster, in a progressively ascendant curve, which extends the accumulated number of deaths (Images 05 and 06). Until April 27th 2020, to double the number of registered

cases, the intervals of time were more spaced, reaching even fifteen days. Exactly on that date fourteen days were completed after the recommendation of flexibilization of the non-essential economic activities, a surely premature attitude, because there was a growth of 208.3% in relation to April 13th 2020, warning that the measures of “selective social distancing” may not have the efficiency in the control of the spread of the disease. Thereafter, the curve with the total of accumulated cases follows increasing and the its number doubles in a faster pace: 164 cases on April 30th 2020, with an addition of 107.6% in only three days; 351 cases on May 5th 2020, an increase equivalent to 114% in five days; 747 cases on May 10th 2020, with an increase of 112.8% in five days. It’s important to emphasize that, on May 15th 2020, the government of Tocantins declared the suspension of all non-essential activities, with a more severe control of the circulation, the so called “*lockdown*”, in Araguaína and other 34 municipalities, in the extreme north of the state, the region so called Bico do Papagaio, and in other ones located at BR-153, until May 25th 2020 (TOCANTINS, 2020d).

However poorly planned social isolation measures and with a bad execution may have social commitments and cause an unintended effect in the prevention of the contagion, as it seems to be the case, since the state reached 1,496 cases on May 17th 2020, what indicates an increase of 100.3% in only seven days, and after other nine days the number doubled again, reaching 3,023 cases on May 26th 2020, with the increase of 102.1%. This decree was revoked by a new one on May 22nd 2020, which recommended “expanded social distancing” measures (TOCANTINS, 2020e). Regardless of the measures, the number doubled again, reaching 6,052 cases on June 8th 2020, with an increase of 100.2% in thirteen days (SES-TO, 2020c) (Image 5). Precisely when the measures of flexibilization of non-essential economic activities were adopted, again, including in the two most affected cities, Araguaína and Palmas (PALMAS..., 2020), and new testing procedures were adopted, prioritizing only hospitalized patients and the suspicious deaths by Covid-19 (LABORATÓRIO..., 2020).

On June 16th 2020, when 90 days of the first notification in the capital were completed, there were 7,573 accumulated cases of Covid-19 in the state (an increase of 406.4% in relation to May 17th 2020) (Image 04 and Table 06), with an incidence of 481.48 cases by 100 thousand inhabitants, while Brazil was of only 454.62 cases. Tocantins, therefore, has started presenting a higher incidence rate than the country’s itself. On that date, 4,435 recovered cases were registered, 118 hospitalizations with patients with or without domicile in the state, at public and private hospital units, equivalent to 3.9% of the total of active cases of Covid-19, and 149 deaths (an increase of 365.6% in relation to May 17th 2020), with a lethality rate of 1.9%. The intermediate geographic region of Araguaína extrapolates the Brazilian incidence coefficient, with 831.18 cases per 100 thousand inhabitants, followed by the incidences in Pará and Maranhão, 828.13 and 886.35 respectively. Furthermore, the region accounts for 71.1% of deaths (19.5% in the region of Palmas and 7.4% in the region of Gurupi) (SES-TO, 2020c; MINISTÉRIO DA SAÚDE, 2020a).

The evolution of the data also shows a more embracing dissemination from the spatial point of view. Since May 3rd 2020, there was the register of Covid-19 cases throughout the ten main urban centers of regional, sub-regional and microregional influence, which municipalities are in a populational range that's equal or above 22,139 inhabitants. These municipalities registered, on that day, 225 cases of Covid-19, in other words, 84.3% of the total of cases of the state. In relation to the other 129 urban centers, which municipalities were in a population range of until 18,440 inhabitants, the first register occurred on April 11th2020, when the notification of a case in Cariri do Tocantins, a border municipality to Gurupi's and located at BR-153. On May 3rd 2020, there was the register of the disease in fourteen, 10.8% of the total of these municipalities, that registered 42 cases of Covid-19, therefore, 15.7% from the total of cases of the state, that, on that date, had 24 municipalities with registered cases, the equivalent to 17.3% of the total (Images 07 and 08) (SES-TO, 2020c).

Table 06: Tocantins: urban centers of regional influence with confirmed cases of Covid-19, on June 16th 2020.

Municipalities	No. of confirmed cases ¹	% total No. of cases	Confirmed rate per 100 thousand inhab.	No. of deaths	No. of days after the first register
Palmas	1.085	14.3	68.98	12	90
Araguaína	3.044	40.2	193.53	41	81
Gurupi	154	2.0	9.79	5	70
Porto Nacional	123	1.6	7.82	2	49
Paraíso do Tocantins	173	2.3	11.00	7	66
Dianópolis	2	0.0	0.13	--	60
Araguatins	132	1.7	8.39	15	33
Guaraí	118	1.6	7.50	4	51
Colinas do Tocantins	152	2.0	9.66	3	47
Tocantinópolis	211	2.8	13.42	4	62
Subordinate Municipalities	2.379	31.4	151.25	56	66
Total Tocantins	7.573	100	481.48	149	90

Source: SES-TO (2020c). Note: ¹ According to the municipality of domicile and registered in the epidemiological newsletter on June 17th 2020.

On May 21st, the pandemic already reached 76 municipalities of Tocantins, corresponding to 54.7% of the total, that, together, counted 2,205 cases of Covid-19 (Images 07 and 08). The municipalities which are the main centers of this urban network segment registered the highest number of accumulated cases, but with a minor participation than the previous one, 73.1% from the total of the state (1,612 cases). On that date, the disease reached 66 municipalities, 51.2% of the total, among those in a populational range of until 18,440 inhabitants, with 593 cases of Covid-19, representing 26.9% of the total and implying the increasing participation on the accumulated number of cases of the state (SES-TO, 2020c).

On June 16th, after 90 days from the register of the first case in the capital, the pandemic reached 105 municipalities of Tocantins, in other words, 75.5% of the total (Images 07 and 08). The municipalities which are the main urban centers registered the highest number of accumulated cases, however with the increasing participation, 68.6% from the total of the state (5,194 cases). On that date, the disease reached 95 municipalities, 73.6% of the total, among those the ones in the populational range of until 18,440 inhabitants, with 2,379 cases of Covid-19, equivalent to 31.4% of the total and maintaining an increasing situation in the participation on the accumulated number of cases of the state (SES-TO, 2020c).

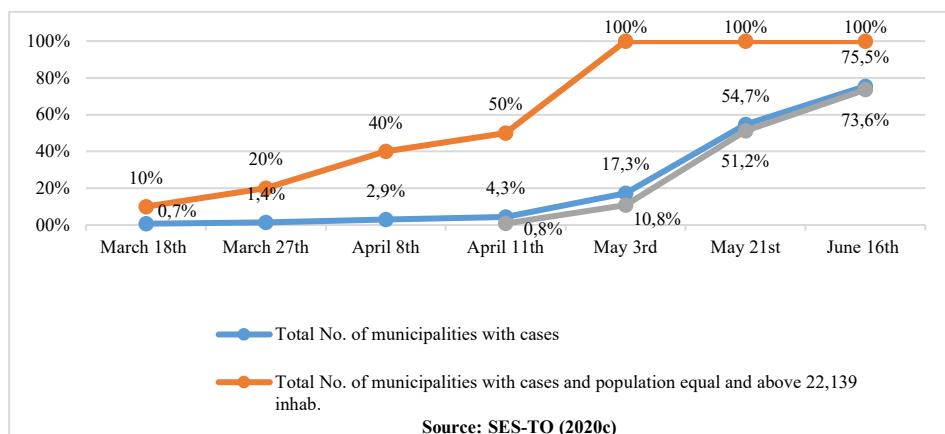


Image 07: Spatial Evolution of the Covid-19 pandemic in the state of Tocantins, from March 18th to June 16th 2020.

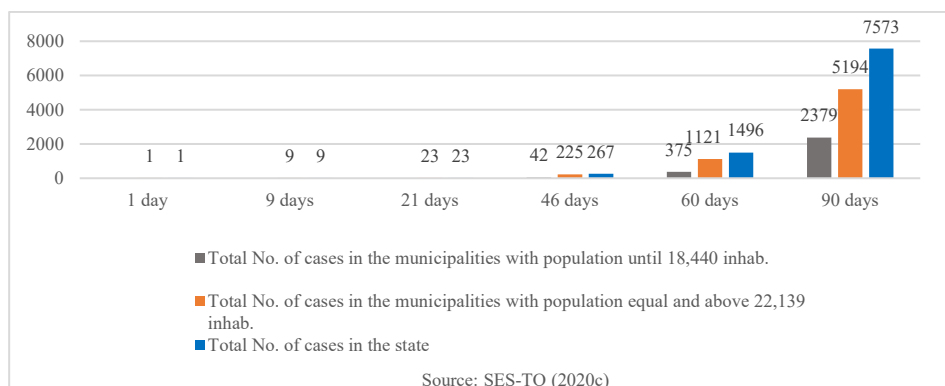


Image 08: Space-time evolution of the Covid-19 pandemic in the state of Tocantins, from March 18th to June 16th 2020.

The analysis of the data show that the diffusion of the pandemic in Tocantins follows ascendant curves as in the number of accumulated cases, with implications in the

amount of people exposed to the contagious virus, as in the number of deaths. Furthermore, it confirms the wide spatial range of the pandemic, which, in terms of municipalities to be reached, what's left is to cover the total of those municipalities in the populational range of until 18,440 inhabitants, with few or none conditions for medical-hospital assistance in more severe cases. That suggests a bigger pressure in public health units in Palmas, Araguaína and Gurupi. Sadly, it indicates a pessimist context with the flexibilization of the economic activities and the consequent increase in the mobility of the population, added up to the insufficient testing and the deficiency in public health services.

First Considerations

Usually, in this last item, the final considerations are presented, however, as the dissemination of Covid-19 is still in course, as in Tocantins as in Brazil, here there's only the first considerations.

The space-time analysis of the dissemination of Covid-19 in this state reveals two main dispersion patterns, a vertical one and a horizontal one, which express, mainly, the hierarchical and complementary natures particular of spatial interactions of the urban network. These last ones have a tendency to involve, in no time, all the urban centers of the regional network segment and also the centers contained in overlapping areas of the main urban centralities, with decisive influence of the transportation routes. In Tocantins, the relevant overlapping areas are the ones that involve the areas of influence of regional centers in the center and north portions of the state, with notorious consequences in the spread of Covid-19, as the critical situation of the region of Araguaína confirms. Thus, it's relevant to alert to the importance of regional analysis as in relation to the evolution as to the measures of controlling the pandemic.

With the convergence of these two main dispersion patterns, there's a faster and wider spread, what resulted in spatial configurations that combine knots, axes and areas, that overcome the state limits, because the main regional influence centers are inserted in a wide space of territorial complementarities, suggesting that the spread of the pandemic in Tocantins is associated to its evolution in this wide regional space. In this latter one, the life of relations reveals itself denser in the north portion, along with Araguaína and its wide area of urban-regional exchanges, as well as in the central portion, where the capital is located, and less dense in the south portion, in the area under the influence of Gurupi. Such conditions put the north portion and the routes along with the main roads in a critical epidemiological situation, due to the deficiency of the health services, which deserves especial attention of the sanitary and political authorities.

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Kelly Bessa

PhD in Geography from Federal University of Rio de Janeiro, Master and graduated in Geography from Federal University of Uberlândia. Currently is effective professor at the Federal University of Tocantins, working on Geography graduation course and Postgraduate in Geography, campus of Porto Nacional, and Postgraduate in Environmental Sciences, campus of Palmas.

Quadra 109 Norte, Av. NS 15, ALCNO-14, Cep: 77001-090, Palmas, TO

E-mail: kellybessa@uft.edu.br

Rodolfo Alves da Luz

PhD, master and graduated in Geography from University of São Paulo. Currently is an effective professor at the Federal University of Tocantins, working in Geography graduation course, campus of Porto Nacional, and in Postgraduate in Regional Development, Palmas campus.

Avenida NS 15, Quadra 109 Norte, North Master Plan, PPGDR Building, Palmas, TO
Cep: 77001-090

E-mail: rodolfodaluz@mail.uft.edu.br

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