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Climate Crisis in Rio de Janeiro City: information agents and territories in Twitter

Crise climática na cidade do Rio de Janeiro: agentes e territórios de informação no Twitter

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ABSTRACT: The present research is the attempt to depict Rio de Janeiro City - Brazil – at a specific moment, when one witnessed an extreme climate event. This attempt took place in Twitter's virtual universe and its aim was to understand the dynamics featuring social participation in processes to produce information about the climate crisis, i.e., identifying information *agents* and *territories*. The analyzed data were collected from publications in Twitter related to the heavy rainfall events recorded in April 2019, in Rio de Janeiro City. These data were collected from Twitter API, in R programming environment. We used the thematic analysis methodological approach at two stages to analyze 375 thousand tweets. This data analysis was added with information provided by IBGE and DATA.RIO. Based on the main results, conditioning factors linked to the digital exclusion of populations mostly affected by the climate crisis, mainly schooling and income of populations living in territories mostly affected by the observed climate event, are determining elements. Results have also indicated the relevance of fighting climate denialism, mainly in public spheres, as well as of creating work agendas aimed at strengthening social participation as mechanism to expand climate governance and to reduce environmental injustices.

Keywords: climate crisis; Rio de Janeiro; Twitter; information; climate justice.

RESUMO: A pesquisa parte da tentativa de retratar a cidade do Rio de Janeiro – Brasil – em uma temporalidade específica, quando ocorre um evento climático extremo. Essa tentativa acontece no universo virtual do Twitter, para então buscar compreender as dinâmicas que caracterizam a participação social no processo de elaboração de

informações sobre a crise climática, ou seja, identificar os *agentes* e os *territórios* de informações. Os dados analisados têm como origem as publicações no Twitter, referentes às fortes chuvas de abril de 2019 na cidade do Rio de Janeiro. Tais dados foram obtidos a partir da utilização da API do Twitter, no ambiente de programação R. Para coletar, tratar, organizar e sistematizar os dados, empregamos o enfoque metodológico da análise temática em duas etapas, as quais nos permitiram analisar 375 mil tweets. As análises desses dados foram complementadas por informações provenientes do IBGE e DATA.RIO. Os principais resultados sinalizam os condicionantes da exclusão digital das populações mais afetadas pela crise climática, principalmente: o grau de instrução escolar e a situação econômica das populações que habitam nos territórios mais afetados pelos impactos do evento climático observado, como elementos determinantes. Ademais, os resultados sinalizam a importância de combater o negacionismo climático – principalmente nas esferas públicas – e, portanto, pautar a criação de agendas de trabalho voltadas ao fortalecimento da participação social enquanto mecanismo de ampliação da governança climática e de redução das injustiças ambientais.

Palavras-chave: crise climática; Rio de Janeiro; Twitter; informação; justiça climática.

1. Introduction

The climate crisis has become the core topic in international political agendas focused on the environment in the last decade due to its civilizational crisis approach (Martinez-Alier, 2007; Roser & Seidel, 2017). Scientific evidences about human intervention in climate changes point towards development models that have been adopted since the Industrial Revolution and that are speeding up critical biophysical issues and producing global environmental changes that have potential harming and/or catastrophic consequences to the terrestrial system (Viola & Franchini, 2012). Therefore, some agendas and actions have been thought and applied by different organizations, institutions, and political and citizen representatives, at international scope (IPCC, 2007). Results found in some research highlight social participation based on social networks' using - from now on, called digital platforms – to build and reinforce governance processes, resilience and climate justice (O'Neill & Boykoff, 2011; Inoue, 2016; Balbé & Carvalho, 2017; Loose & Girardi, 2017).

As shown in the research by Van Dijck (2022), nowadays, online digital platforms not just changed social and civil practices, but also went deep in all sectors of society, i.e., they have been changing market dynamics, labor relationships and institutions. This process shines light on the fact that digital platforms can influence political communication and, consequently, democratic processes when it comes to environmental governance. According to this transformation process, Van Dijck and collaborators (2018) state that digital platforms would help building social structures we are inserted in by heading to what these authors call platform society. These structures produce an inseparable relationship between digital platforms and social structures. Several complex issues of public interest can be found in the very core of social structures, among them one finds topics like environmental governance and climate crisis.

The concept of climate-related environmental governance was addressed by different professional fields – scholars, politicians, environmentalists, social organizations' managers and other agents from different action fields – and it has been discussed and outspread since the 1980s (Stoker, 1998; Biermann

et al., 2009). This concept's applicability aims at embodying demands from different scientific fields, political agendas and objectives to be worked on (Stoker, 1998). In other words, including different segments of society in decision-making processes focused on potential effects and risks as ecological debit variables.

The ecological debit addressed in environmental studies has been discussed in-depth since the 1990s, after more than 2 thousand climatologists, and other scientists, concluded that Earth surface had reheated over the 20th century (Porto-Gonçalves, 2017). These conclusions were taken as reference, as well as the calculation by Parikh (1995), whose results pointed out the uneven rates of excessive pollutant gas emissions by industrialized countries, i.e., ¾ of global emissions.

As for the pollutant gases agenda, "asymmetric carbon dioxide emissions are an example of environmental injustice at international level" (Martínez-Alier, 2007, p. 305). We agree that the concept of environmental injustice features environmental risks unevenly imposed to populations suffering with lower income, and with limited political and information resources (Acselrad, 2013). Accordingly, climate injustice emerges from unevenness in the distribution of impacts caused by extreme climate events on the most socio-economically vulnerable groups (Milanez & Fonseca, 2011).

The literature points out that, although the climate change issue became object of study by the Brazilian scientific community in the last decade, scientific productions remain incipient in comparison to the international context (Freitas & Paiva, 2018). Conclusions in the study by Schäfer and Schlichting (2014) show that information on climate changes and, in some cases, far from scientific explanations, have been exponentially growing in the internet. Therefore, wrong representations highlight some gaps in the scientific communication field focused on assessing this phenomenon, mainly at digital platforms' scope. These gaps not just evidence productions' quantitative aspects, but also the qualitative prospect of climate injustice and determining contexts, as well as extreme climate events that pose risk on the lives of communities in the most socio-environmentally vulnerable territories (Andrade *et al*., 2020).

We elaborated the present research by acknowledging the risks posed by extreme climate events, mainly those posed over the populations mostly lacking policies aimed at preventing and mitigating the adverse effects of climate changes, since it aims at identifying information agents and territories in Twitter during a specific extreme climate event. This research is justified by records about the rainfall event observed from April 7th to 10th, 2019, in Rio de Janeiro City, as extreme climate event, given the registered large water volume. Rocinha neighborhood recorded 343.4mm of rainwater within 24 hours, and it stresses adverse risks and effects of this event on this community.

The following hypothesis was advocated based on this extreme climate event in Rio de Janeiro City: environmental governance networks focused on climate get stronger through discursive production in digital platforms – in our case, Twitter –; it represents the population's power to participate in information elaboration processes. This discursive production got representativeness when it happened along with the event in question, i.e., this is a very peculiar way to produce information, involvement and engagement of different social segments in discussions about different issues (O'Neill & Boykoff,

2011; Balbé & Carvalho, 2017). Digital platforms also evidence different quantitative and qualitative exclusion indicators applicable to some social groups, mainly when it comes to building a narrative closer to the reality experienced in territories that suffer the most with climate change impacts.

The present article was divided into 5 sections to trigger a coherent discussion based on the aforementioned aim and hypothesis. The first section, the present introduction, presents the initial elements forming the research, mainly aspects allowing the debate about the concept of environmental governance associated with climate changes and with one of the main environmental challenges of our time. The second section – research theoretical references – approaches a literature review about ideas and concepts linked to environmental and climate justice linked to digital platforms, among other topics, in order to start the discussion about the Brazilian political denialist agenda about the herein addressed climate emergency.

The third section regards research methodological aspects; we describe the stages, categories and data collection processes. We also justify our option for using information available in Twitter and that provided by IBGE and DATA.RIO, from the thematic analysis methodological viewpoint. Our choice for using Twitter was substantiated by its representativeness in comparison to the other digital platforms, since it plays essential role in organizing mechanisms to forge bond structures among topics approached in it. Twitter emerges as space for negotiations between individual and collective actions that help gathering common interests through its hashtags and, most of all, because of its strong potential to gather political mobilization (Balbé & Carvalho, 2017).

The section dedicated to results and discussion – fourth section – introduces the main collected empirical data and presents contextualized analyses and reflections. These reflections highlight some likely existing associations between environmental governance and climate injustice in digital platforms – in our case, Twitter – in a city marked by inequalities and segregation during an extreme climate event. These associations, such as poverty levels in residences with under 6-year-old children and low schooling, shine light on the emergency in assessing different profiles of socio-economic exclusion related to climate change impacts and on the perception about this issue and the population's potential to encourage mobilization to claim for public policies capable of potentiating collaborative governance.

The conclusion, in the fifth section, points out, among other aspects, schooling and economic status as likely conditionings for the digital exclusion suffered by populations mostly affected by the climate crisis. Besides digital exclusion, this section also highlights the silence, or even the climate denialism, in the analyzed discursive productions – 541 tweets –, because terms "climate changes" and/or "global warming" were mentioned only 53 times in the messages. This finding points out not just the article's social relevance in helping broadening the environmental-studies scientific field, but also in showing limitations inherent to the study itself – when it comes to lack of data. This data shortage imposes new commitments and work schedules guided by the need of reinforcing networks against environmental and climate injustice, based on a broader sense of environmental governance.

2. Theoretical references

Climate justice – as concept questioning climate injustice processes – comprises ecological debit risks and their asymmetric impacts, mainly those posed on political minorities and vulnerable groups that live in territories lacking assistance from governmental spheres (Herculano, 2008). Accordingly, some concern prevailed in the *Bali Principles of Climate Justice* (2002), on the very basis of this concept's development. It was one of the first documents elaborated by different social segments. Non-governmental organizations and organized social movements played lead part in the process to elaborate this document, which gathers several relevant aspects, among them, one can highlight the following concerns:

> Whereas if consumption of fossil fuels, deforestation and other ecological devastation continues at current rates, it is certain that climate change will result in increased temperatures, sea level rise, changes in agricultural patterns, increased frequency and magnitude of "natural" disasters such as floods, droughts, loss of biodiversity, intense storms and epidemics (Corp Watch *et al*., 2002).

Even knowing that the concept of Climate Justice gained visibility in the last years, its applicability, in practical terms, remains a challenge. Some controversies have been on since the very beginning of discussions and the elaboration of agreements focused on regulation processes aimed at mitigating climate changes. On the one hand, the statement aimed at creating mandatory limits for the emission of gases that dangerously interfere with the climate system remains (IPCC, 2007; IPCC, 2014); however, documents produced during many events promoted by the Climate Summit were not strong enough to determine the accountability of big corporations for emissions of polluting gases. It is even more evident when one observes the outcomes of legal suits against corporations responsible for high-impact environmental crimes committed in territories more vulnerable to the interests by the international financial market and, consequently, for consequences to the terrestrial system climate (Belchior & Primo, 2016; Brondízio & Le Tourneau, 2016; Porto-Gonçalves, 2017).

The proposition of the herein developed hypothesis goes against the national discourses and political climate denialism acts; mainly the political agenda adopted by former Brazilian president, who issued Provisional Measure (PM) 870, from January 1st, 2019, to disrupt important environmental agendas. Among these disrupted agendas, one finds "lack of climate change approaches in the spectrum of competences of the Ministry of Environment (MMA)" (Andrade, 2019, p. 211). Thus, lack of agendas has many meanings, because, as stated by Viola & Gonçalves (2019, p. 1), "the country has the power to harm the Earth System, but may also be an important catalyst for innovative answers to the challenges posed by the Anthropocene".

The role Brazil can play in nowadays climate emergency scenario, and advocated by Viola & Gonçalves (2019), meets results on other research whose authors highlight that the meaning adopted to define the Brazilian environmental agenda aimed at climate changes depends much more on political strength and will than on environmental factors (Viola & Franchini, 2012; Inoue, 2016). We understand that in order to change the climate denialism reality installed in the decision-making political

spheres, it is essential having social communication to build agendas focused on reinforcing climate governance.

In the last few years, digital platforms, mainly Twitter, have become a communication channel used by different social segments. Twitter, in the academia, gained special attention by researchers from different knowledge fields who have made multiple analyses about this digital platform's influence and impact on the following fields: collective health, renewable energy financial markets, social and environmental policies, among others (Giustini & Wright, 2014; Kostkova *et al*., 2014; Severyn & Moschitti, 2015; Balbé & Carvalho, 2017; Reboredo & Ugolini, 2018; Lopez *et al*., 2020).

Balbé & Carvalho (2017, p. 142) used other terminology to define digital platforms and highlighted that "the literature review shows that the investigation about climate change communications in social network contexts remains incipient and leans on contents [written] in English". In other words, topics related to the environmental field, mainly to climate changes, could not have the attention of Twitter users to the extent of producing discourses substantiated by the herein approached subject. Besides discussions about digital platforms, conclusions in the study carried out by Freitas and Paiva (2018) point out that the development of a literature focused on climate changes in the country needs further research on Brazil's physical, economic and political features; on such a fashion to take this discussion closer to the context of national issues.

The low representativeness of climate change communications in digital platforms, mostly in Twitter, allows thinking that this research field remains at initial stages in Brazil, and only few results in empirical studies can be gathered due to low data representativeness (Andrade *et al*., 2020). This phenomenon evidences other challenges related to governance, in a much broader sense. In concrete terms, as stated by Van Dijck (2022, p. 32), the fact that "after a decade of euphoria towards the platforms, when technology companies were celebrated by empowering common users, other issues have increased in the last three years. From her viewpoint, "disinformation, fake news and hate discourses have spread in YouTube, Twitter and Facebook, it poisons the public discourse and influences elections" (Van Dijck, 2022, p. 32-33).

Disinformation, fake news and hate discourse processes in Twitter point out not just the weakness of discussions focused on elements that feature governance, from its broadest perspective, but also clarify issues regarding climate governance. Consequently, they bring to debate other elements that emerge from *the societies of risks* (Beck, 2010). It is important highlighting lack of information, which reinforces the scenario of vulnerability, about the eminent impacts from climate changes (Loose & Girardi, 2017).

With respect to Twitter, as digital platform, Van Dijck (2022, p. 34) has warned about the fact that "platformization is mainly boosted by commercial interests that oftentimes precede other social values". Thinking about these values allows considering this negotiation process at all governance levels, including in digital platforms. We must take into account the prevalence of some agendas over others as strategy to make certain topics infeasible and veiled. As for the environmental discourse case, this systematic negligence aims at favoring silence about risks posed by the climate crisis and

by environmental injustice processes (Milanez & Fonseca, 2011).

Accordingly, we acknowledge that the sense of *society of risks,* as advocated by Beck (2010), has also contributed to reflections about climate changes associated with wealthy social production, which is systematically followed by the social production of *risks.* The aforementioned author states that "consequently, problems and conflicts triggered by the production, definition and distribution of scientifically-technologically produced risks overlaps distributive issues of the scarcity society" (Beck, 2010, p. 23). The sense of social production of *risks* makes us think that hierarchies remain and get stronger in territories missing the implementation of environmental-governance public policies linked to environmental and climate injustice (Martínez-Alier, 2007).

We agree that the sense of *society of risks* (Beck, 2010, p. 23), somehow, hides limitations inherent to environmental risks and to the fact that they are supported by the most vulnerable population groups and by political minorities; therefore, they become insoluble, invisible but, at the same time, they grow (Martínez-Alier, 2007; Herculano, 2008; Milanez & Fonseca, 2011). These risks also shine light on the logics that operates in vulnerability production, because the last decades' economic development, which was accelerated by globalization, was substantiated by the following aspects:

a) Wealth concentration and iniquities' increase – either in counties or between countries;

b) Observation of global ecological risks, such as the so-called greenhouse effect, deforestation and biodiversity destruction, among others (Freitas & Porto, 2006; Andrade, 2020).

3. Methodological aspects of the research

The present article gathers results from a quantitative and qualitative research that comprises knowledge on inter-disciplinary environmental studies based on the herein introduced hypothesis, aim, justification and theoretical references. It discusses a series of topics that emerge as structuring elements of environmental issues in a broader way, including climate injustice. Thus, we focused our attention on Rio de Janeiro City – the *locus* of the present research -, which is a territory marked by social inequalities and segregation (Lago, 2015). This city, just as many others in the country, emerges as territory potentiating climate injustices. The inequality and segregation argument, as highlighted in the research by Lago (2015, p. 40), is not recent, because

> At the beginning of the current century, it was already possible locating the place of each social class in Rio de Janeiro's urban space. The separation process between poor and rich was launched at late 20th century, when the rich social classes were displaced to new, recently built, neighborhoods, special for them. During this time, and driven by the private capital – mainly by tram companies – and by the State, the city border spread quickly towards the Southern and Northern Zones, and incorporated areas such as the Botanic Garden, Copacabana, Ipanema, Tijuca and Vila Isabel. This expansion, however, only allowed the displacement of the highest classes, and urban workers were relegated to worker-neighborhoods in downtown areas, and those who could afford daily transport expenses went to suburban neighborhoods that, after the trains were launched, lost their rural profile.

Given the inequalities and segregation scenarios associated with the herein introduced theoretical elements, the present article is the attempt to depict Rio de Janeiro City within a specific timeframe, when the city witnessed an extreme climate event. This attempt took place in Twitter's virtual environment and aimed at better understanding the dynamics featuring social participation in processes to elaborate information about the climate crisis and extreme climate events. In concrete terms, identifying information agents and territories to further relate them to other elements featuring the social and economic dynamics of populations living in this city. From the methodological viewpoint, these elements consist of a set of open data mainly made available by the following entities: Brazilian Institute of Geography and Statistics (IBGE), Pereira Passos Institute of Rio de Janeiro City and DATA-RIO.

The herein adopted methodological design used DATA.RIO portal's database because it gives access to information bond to fifteen categories, among them, territory and environment, housing and urbanism, population, economy and schooling. This open portal, which was launched in 2014 by the Municipal System of Urban Information, also known as SIURB, gives fast and interactive access to information, since it embodies a new planning, integration, management model to outspread City Hall information (DATA.RIO, 2020). Therefore, we see the relevance of relating information from the databases - IBGE and DATA.RIO – to other empirical research data in order to better understand conditionings determining information agents and territories in Twitter based on the herein approached topic.

Decision-making about research data happened because of considerations found in the literature, mainly in publications stating that, nowadays, digital platforms cause a true revolution in the communication field since they provide more interactive and broader approaches (O'Neill & Boykoff, 2011; Andrade *et al*., 2021; Van Dijck, 2022). Crosbie (2002) used terminologies in social networks to highlight three features that have potentiated the aforementioned revolution:

a) Capacity to deliver individualized messages simultaneous to those with access;

b) Controlling the content shared by each involved individual;

c) Dependence on new technology media.

Twitter is a digital platform whose features allow users to send and receive personal updates from other contacts by using 280 letters[1], at most. Based on such features, the present research aims at addressing issues related to the approach and production of discourses about climate changes in digital platforms. Thus, the analyzed data were collected from Twitter publications about the strong rainfall event from April 2019, in Rio de Janeiro City. These primary data were collected in two stages – as shown in Figure 1 – by using Twitter's API, in R[2] programing environment (R Core Team, 2019) through free-use license.

[1] Twitter had increased to limit of 140 letters for posts. More information is available at <https://about.twitter.com/pt.html>.

[2] Codes available at: https://github.com/tarssioesa/twitter_mudancaclimatica?fbclid=IwAR1daVZvEL7cS3pNFMEydY_HUuOnNwlkHxLgRz48YM2yhcOZUEh1nkWd4rI

FIGURE 1 – Research data collection stage by using Twitter's API
SOURCE: elaborated by the authors

We adopted the thematic analysis methodology to organize, treat and systematize the recorded data, because this approach is used to analyze the existing patterns in datasets, i.e., the core concept – object of analysis – is the topic itself (Braun & Clark, 2006). The previously presented topics and/or words give the current research an exploratory profile, mainly if we take into account conclusions found in Andrade and collaborators (2020, p. 16), who highlight the existence of other implicit and explicit "approaches" featuring the discursive production about climate changes in Twitter. They referred to this topic's invisibility in digital platforms, as well as to the low participation level recorded for government entities in the process to produce tweets about this particular issue. We have analyzed three topics in order to find answers to these implicit and explicit approaches: neighborhoods, users and climate changes. The two first ones were the present object of interest

- *Neighborhoods* – refer to publications' distribution during the extreme climate event related to the neighborhoods mostly affected by it in Rio de Janeiro City;
- *Users* – regard profile groups in Twitter, their features and published semantic contents.

3.1 Neighborhoods

We selected the following neighborhoods in Rio de Janeiro City based on the criterion regarding rainfall intensity in the herein assessed time and territory: Rocinha, Alto da Boa vista, Barra, Jardim Botânico, Copacabana, Vidigal, Jacarepaguá, Urca, Recreio, Tijuca, Laranjeiras and Campo Grande. We adopted this methodological strategy given the lack of geolocation in most Twitter publications; this resource is not a standard service in this platform, so users must activate it. We opted for searching Twitter publications about Rio de Janeiro neighborhoods and for inferring about their potential to produce news or of being lead in these publications. We

analyzed the following information after finishing this selection process:

a) Number of citations about each one of the neighborhoods;
b) Time linked to these citations;
c) Correlation between number of citations and rainfall intensity in the region;
d) Some of the population's demographic features.

This decision tree allowed creating scenarios that, based on reading the set of variables, can help better understanding of the number of tweets mentioning certain locations – *information territories* –, regardless of rainfall volume.

3.2 Users

After the two data collection stages were over, as described in Figure 1, we selected 50 profiles in the most cited Twitters during the herein assessed period-of-time. This selection took place according to publications' association with the extreme climate event, as well as to the publication networks formed by these agents based on their interactions, sharing or comments during the assessed time. The most cited profiles were split into groups that identify them as *information agents:* traditional and independent media representatives, Civil Defense, among others; politicians in representativeness positions; and civil society. These profiles' selection meets a specific research demand, namely: assessing discursive associations in messages sent to these *information agents* during the extreme climate event, i.e., associations between the event and awareness of the climate crisis.

4. Results and discussion

The vulnerability topic addition to climate crisis prospection helps showing additional difficulties experienced by certain territories and populations regarding environmental issues (Freitas & Porto, 2004; Herculano, 2008; Milanez & Fonseca, 2011). Reinforcing social practices focused on global climate governance in these territories is justifiable because social participation helps elaborating citizen discourses and claims in digital platforms (Biermann *et al*., 2009). It is so, because the role played by digital platforms in people's engagement in historical claims about ecological debit reparation is linked to three keywords:

a) *information* access and production
b) *Interactivity* in discursive production;
c) *Inclusion* of new individuals, communities and social organizations (O'Neill & Boykoff, 2011).

Based on these elements, the aim of the present study was to disclose some aspects featuring and conditioning social participation in discourse's elaboration and in access to information.

We have paid closer attention to digital exclusion, i.e., to the possibility of accessing the internet and digital literacy skills to use it, among other aspects (Martin & Robinson, 2007; O'Neill & Boykoff, 2011; Araujo *et al*., 2018). Data in TIC Domicílios (2018) – one year before the present data collection – pointed out that 70% of Brazilian residences located in urban zones had access to

the internet. However, these data presented significant disparities between social classes and family income:

a) As for the richest families (classes A and B), 96.5% of the houses had internet signal;

b) When it comes to the lower levels in the pyramid (classes D and E), this index reached 59% a – houses with an internet signal;

c) With respect to the population with family income lower than 1 minimum wage, 78% of people with access to the internet only used it in their mobiles (TIC Domicílios, 2018).

Accordingly, it is interesting to understand tweet publications about climate changes in Rio de Janeiro City after an extreme climate event. In order to reach such a goal, we took into account the dataset observed in Table 1.

Some information stands out in the data set shown in Table 1, mainly that translating social inequalities and segregation in Rio de Janeiro City.

TABLE 1 – Introducing neighborhoods based on ascending rainfall volume order – within 24 hours – and other research variables.

Neighborhoods	Rainfall volume 24hs*	Mean rainfall rates in April between 2015 a 2019	Single tweets#	Area	Residences				Illiteracy rate
					Population	Total	% in slums	% poor individuals (under 6 years old)	
Rocinha	343.4	176.8	62	143.32	69,356	23,399	99.99	20.84	0.067
Alto da Boa Vista	341.2	202.36	8	3,149.57	9,343	3,123	38.93	7.06	0.030
Barra	335.2	140.52	82	4,185.06	135,924	51,167	0.80	4.93	0.005
Jardim Botânico	334.4	154.52	147	268.92	18,009	7,051	4.05	2.69	0.006
Copacabana	329.4	140.8	45	410.09	146,392	66,250	5.25	5.62	0.009
Vidigal	312.2	147.96	11	162.14	12,797	4,304	80.11	19.04	0.058
Jacarepaguá	289.6	103.4	76	7,579.65	157,326	53,500	60.91	15.58	0.063
Urca	254.8	111.64	3	231.90	7,061	2,850	2.77	4.15	0.008
Recreio	236.8	126.6	15	3,065.56	82,240	28,405	22.57	7.38	0.022
Tijuca	196.0	112.28	70	1,006.56	163,805	62,544	10.20	8.46	0.014
Laranjeiras	189.2	104.84	6	249.35	45,554	18,865	3.16	2.72	0.008
Campo Grande	171.4	95.2	16	10,444.51	328,370	105,123	5.65	15.42	0.026

SOURCE: elaborated by the authors. Data provided by IBGE (2010), DATA RIO (2019-2020) and research data. Warning Rio System of Rio de Janeiro City Hall (2020). *Rainfall indices refer to the greatest rainfall event during the assessed period – April 7th to 10th, 2019. #Refers to the number of citations about neighborhoods based on their unicity, i.e., publications that are shared parts from other publications.

Both elements – inequality and segregation – expose factors that, according to O'Neill & Boykoff (2011), can set the likely citizen participation in social media in issues related to environmental and climate crisis. This scenario is even clearer if we carefully observe data about communities living in territories geographically dominated by slums, which, historically, lack basic rights, such as education, health, basic sanitation and security. According to data by IPCC (2007), communities lacking these fundamental rights are more exposed to varying risks from ecological debit. We understand that the sense of risk, as previously mentioned, is complex, since mankind lives situations driven by dangers like floods, storms, earthquakes or volcanic eruptions for thousands of years. These events were not observed as risks until the 16th and 17th centuries, but as dangers, fatalities or difficulties (Habermann & Gouveia, 2008).

Although the sense of risk – as it is found in the literature – walked along the formation of National States in Europe, fact is that Global South peoples, who lack economic resources, are the ones that have suffered, mainly in the last decades, with the crashing effects of the climate crisis and of other environmental issues (Porto-Gonçalves, 2017; Roser & Seidel, 2017). Based on such a scenario, it is worth highlighting that "climate change is a 'natural' phenomenon only insofar as it occurs 'in nature'. Unlike the movement of the moon, climate change is largely man-made and as such can be stopped, slowed down, or accelerated by human action" (Roser & Seidel, 2017, p. 2). However, in order to slow it down, the population must be encouraged to participate in decision-making processes, as well as have the right conditions to join debate spaces focused on reinforcing environmental governance.

With respect to the present research, information shown in Table 1 also evidence some elements that feature the association between environmental governance and climate injustice, the production of discourses in Twitter and access to information after the extreme climate event in a city marked by social inequalities. The set of data gathered in the present research shows that rainfall in April 2019 was the most voluminous of the last 22 years; it reached rainfall rate of 343.4mm, and placed Rio de Janeiro City in a crisis (DATA.RIO, 2019). Based on this geographic context, the local population's life was affected in different ways: deaths (10 people), landslides, traffic jams, tree falls, impairments in public transportation sectors, lack of electric power, among others (Andrade *et al*., 2020).

The neighborhood mostly affected by the rain, according to data in Table 1, presented different social inequality profiles and, consequently, differences in terms of the risks and vulnerability posed by the extreme climate event on each community, to the detriment of its territory. This representation is the very basis for thinking about environmental and climate injustice processes imposed to the following neighborhoods: Rocinha, Vidigal and Jacarepaguá, which hold 99.99%, 80.11% and 60.91% of their residences located inside slums, respectively (DATA.RIO, 2019).

Information available and the herein used literature restate that, due to the frequency "one has observed extreme climate events with disruptive consequences to cities' social fabric, we aimed at triggering the discussion about environmental vulnerability seen as historically set" and distributed in a socially uneven way (Acselrad, 2015, p. 58). This inequality is clear when we analyze the economic feasibility observed through data in Table 1. Actu-

ally, poverty levels in residences with children under 6 years old in Rocinha reached 20.84%; 19.04% in Vidigal and 15.58% in Jacarepaguá. This finding highlights that the environmental and climate injustice topic must be assessed based on its multiple cross-sections. According to Herculano (2008), the environmental injustice topic remains incipient and hard to understand due to the extreme inequalities observed in the Brazilian society, because it is assumingly understood as a place specific to several disputes involving environmental issues.

Social mobilization in Rio de Janeiro City, at these disputes scope, during the extreme climate event, took place in different segments of society. Based on research aims, we paid closer attention to digital platforms' using, mainly to users who have sent messages in Twitter. These messages not just show the information agents, but also allows creating scenarios from aspects featuring the information territories. Information territories' data have highlighted the high potential of Jardim Botânico neighborhood to be referenced in Twitter publications – it recorded 147 publications, i.e., 32% of the 541 tweets mentioning some neighborhood in the city. Although the volume of rain was larger in Rocinha, Alto da Boa Vista and Barra neighborhoods, respectively, showed more significant rainfall effects and, Jardim Botânico accounted for the highest frequency of posted tweets.

The cross-sectional analysis applied to data in Table 1 allows assuming that Jardim Botânico sovereignty to occupy spaces in Twitter is related to its power to produce information, as well as to drive and potentiate environmental governance processes. This power – generating engagement – can be an important element for the analysis of extreme social inequality contexts, such as the case of Rio de Janeiro City. It is likely that this digital event – number of tweets mentioning Jardim Botânico, to the detriment of other neighborhoods – results from social disparities that also reflect access to information and the use of digital platforms. This argument emerges from data regarding population index recorded for Rocinha neighborhood in comparison to Jardim Botânico.

With respect to Jardim Botânico neighborhood, it is possible restating two important issues to be closely observed:

a) The low poverty level in comparison to other neighborhoods, and it translates significant likelihood of having access to and of using electronic assets;

b) Schooling recorded for people living in this neighborhood, since its illiteracy rate reaches 0.006; it represents one thousand times less than the population living in Rocinha (6.40) (IBGE, 2010).

Both issues can set and/or determine population participation power in digital platforms, not just when it comes to climate crisis. If we take into account the illiteracy rate in the analysis applied to empirical evidences in the present research, we can also consider the results found by O'Neill & Boykoff (2011) and outspread in CIBDER Report. They investigated the behavior of youngsters in digital platforms and their association with school and digital literacy.

Regarding the variable "illiteracy", CIBER Report highlighted that "although there is an intuitive assumption that users are expert searchers, it is dangerous to assume that digital literacy and information literacy go hand in hand" (O'Neill & Boykoff, 2011, p. 238). Therefore, we also took into

consideration the interference of other variables with this digital event, i.e., the number of tweets mentioning Jardim Botânico neighborhood – 147, in total. One of these interferences is related to the presence of one of the biggest information centers in the country – Rede Globo – and of other news channels' studios in this neighborhood. It also counts on a fluctuating population that occupies job positions at different sectors. Assumingly, this fluctuating population also had a hard time going back home, and it can be inferred through differences in intervals between the rainiest period (06:15pm until 10:10 pm) and the peak of publications (11:00 pm), as shown in Figure 2.

Research data shown in Figure 2 help better understanding the information territories and, consequently, they take us to agents who produce tweets, i.e., users. According to data made available by Agência Brasil (2019), estimates show that 51% of the world population does not use the internet. In total, 74.9% of the Brazilian population has residential internet access and 97% of it only has access to the internet in mobile phones (PNAD, 2018). However, internet use in Brazil, similarly to other developing countries, is linked to regional and socio-demographic variations (Araujo *et al*., 2018). Araujo and collaborators (2018) highlight the following aspects about these variations: income, schooling, age, sex, rural and urban zone, as determining elements. At the first order, one finds income and schooling, respectively, and they emerge with higher variation degree when it comes to digital exclusion in Brazil and abroad (Martin & Robinson, 2007; O'Neill & Boykoff, 2011; Araujo *et al*., 2018). At the second

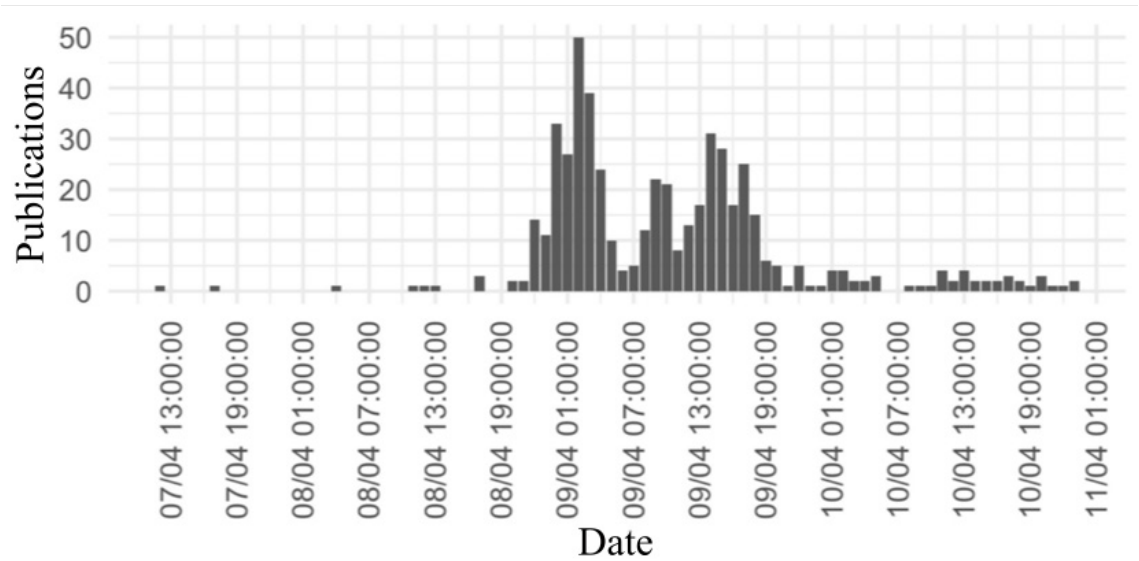

FIGURE 2 – Date – from April 7th to 11th, 2019 – versus number of publications in Twitter about the highlighted neighborhoods.
SOURCE: elaborated by the authors, Research data (2019).

order, one can observe evidences seeking to explore factors such as competence, digital skills and TIC's using, as well as users' behavior, motivation and attitude (Araujo *et al.*, 2018).

If we take into account this digital exclusion, at first and second order, data point towards some features of tweets sent by different information agents about April rainfall event in Rio de Janeiro City. However, before we address the analysis applied to these agents, it was necessary carrying out a filtering procedure among the most cited users to identify users who really related to the climate event of interest. In order to do so, we plotted a fork chart of these users to show how intense the citations were. Based on this representation, it was possible observing a core group whose publications were about the climate event in Rio de Janeiro City, as well as peripheral groups that were further analyzed; those that were not linked to the research were excluded. After this stage was over, it was possible identifying the information agents – users – who stood out in tweets' production during the extreme climate event. Among these productions, one finds the participation of communication and citizenship means, as depicted in Figure 3.

Data in Figure 3 show the following social segments and institutional representatives:

a) Public transportation companies;
b) Municipal and state public institutions;
c) Politicians in representative positions;
d) Traditional media;
e) Journalists and communicators;
f) Independent media;
g) Civil society.

Two aspects prevailed among data in the analyzed tweets. The first one regards awareness, by all agents, of the rain event in April linked to an extreme climate event; therefore, to significant impact over the population. The second aspect is associated with the words "climate changes" and/or "global warming" in tweets sent out by almost all analyzed social segments, except for messages posted by civil society – it totaled 53 tweets.

Lack of words "climate changes" and/or "global warming" shows other analysis possibilities that overcome the digital exclusion elements, which are among the first and second order variables. It translates climate crisis invisibility processes in the agendas of public and private agencies, about discourses produced by politicians in representative positions, and in messages sent by social communicators, among others. Research data suggested that the climate invisibility phenomenon, and contexts the research was carried out in, can be in-depth assessed in the future. These results restate the arguments by Martínez-Alier (2007), according to whom, the environmental agenda was always made unfeasible and neglected.

Research information highlighting lack of terms "climate changes" and/or "global warming" was similar to data recorded in a research about the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21). The similarity aspect is expressed by differences between the most active actors in Twitter, in which citizenship emerges as sovereign; on the other hand, there are no records of tweets from institutions and political representatives focused on the object of analysis (Balbé & Carvalho, 2017). Research data suggested different possibilities to explain this gap, among them we can mention

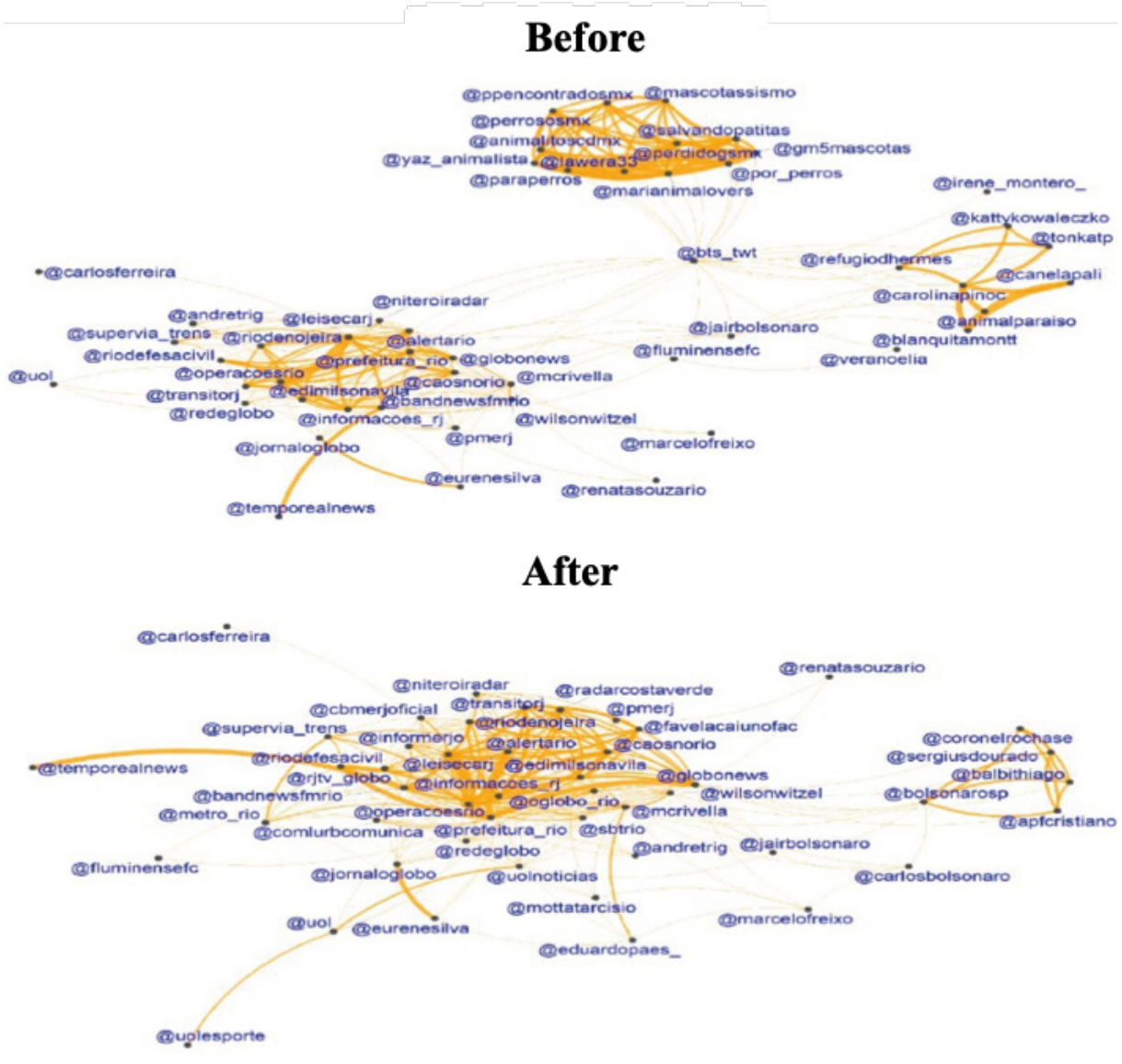

FIGURE 3 – Tweets' production, and core and peripheral groups.

SOURCE: elaborated by the authors. The figure was plotted in R language (R Core Team, 2019). Research data (2019).

a) Lack of awareness of climate changes as real and urgent issue;

b) Lack of public institutions' agendas focused on climate governance;

c) Little political interest in representativeness positions, and in adding issues linked to the climate agenda to their discourses;

d) Likely denialism towards climate changes, among other aspects that still must be assessed.

5. Conclusions

Empirical evidences found in the present research depict the association between environmental governance, and access to and discursive production in Twitter; therefore, climate injustice scenarios in Rio de Janeiro City – Brazil – during an extreme climate event. These evidences enable observing lack of participation by populations mostly affected by the climate crisis, likely due to social inequality in accessing basic rights, such as education. The production of 541 tweets after an extreme climate event, accountable for the lives of 10 people, shows the information territories that can help reinforcing environmental governance given the climate crisis. At the same time, it reinforces digital exclusion conditionings: *population's schooling* and *economic status* as determining elements.

The argument substantiating the two introduced conditionings – schooling and economic status – is based on data in Table 1. Jardim Botânico neighborhood presented low illiteracy – 0.006 – and 2.69% poverty (IBGE, 2010); it was mentioned in 32% of the selected tweets, and it was followed by Barra, Jacarepaguá, Tijuca and Rocinha – 15%, 14%, 13% and 11% -, respectively. Rocinha neighborhood recorded the highest illiteracy rate – 6.40 – and 20.84% poverty, among the assessed neighborhoods (IBGE, 2010); however, even after recording the highest rainfall rate, it ranked the fifth position in citations in the analyzed data.

Besides the digital exclusion conditionings for climate governance, we must point out the participation of information agents, i.e., users who have produced 541 tweets, which were the object of analysis in this research. The relevance of these tweets is related to awareness by all information agents of the April rain as exceptional climate event and about its significant impacts on the population. By acknowledging this event's exceptional profile, we can observe that these messages go against national political agendas adopted by the administration of former president Jair Bolsonaro, who, in the last few years, adopted climate denialism positions and acted to discourage empirical evidences found by a whole diversity of scientists at national and international scope.

In a forceful way, results in the present article point out the need of reinforcing environmental governance networks to fight climate injustice processes. It is so, because even these same information agents recognizing the exceptional profile of this climate event in Rio de Janeiro City, their tweets did not mention the terms "climate changes" and/or "global warming", except for messages sent by civil society – it totaled 53 tweets. Lack of these words translates countless possibilities that still have to be broadly assessed, mainly given the more and more extreme climate events that have been observed.

Based on the herein presented empirical evidences, the present article aimed at helping broadening and reinforcing the epistemological field

focused on environmental governance networks. Thus, these contributions head towards the social field, given its scientific communication approach transposition to the population in order to reinforce social struggles against environmental and climate injustice. This article's originality lies on discussing core issues related to discursive production about climate changes, in digital platforms – in our case, Twitter -, within a territory marked by social segregation and inequality. In other words, this originality resulted from a socio-environmental demand observed in the very core of the Brazilian society. In concrete terms, reporting, in research media, the daily reality of populations made vulnerable by State absence, negligence and omission of public policies focused on resilience and on mitigating climate crisis' devastating impacts.

Besides the listed issues, the present research also has ethical-political implications, including the knowledge-production perspective as way to fight the climate denialism installed in the Brazilian society in the last few years. Therefore, its aim was to report climate injustice processes witnessed in the most socio-economically vulnerable territories. Although it was acknowledged that the research has some limitations, among them,

a) Lack of consolidated literature that – based on national political, economic, social and environmental dynamics – addresses conditionings that reinforce climate injustice processes;

b) Low production of empirical data in Twitter digital platform relating extreme climate events to climate changes, as phenomenon that points out how scientific productions' results are far from the daily lives of the most affected communities, worldwide.

The two limitations presented have been the bases of new relevant agendas to be worked on, mainly at the scope of struggles against climate injustice. One of these agendas is associated with high-impact knowledge production about "development" stages and, consequently, about the outcomes of extreme climate events in certain territories that lack public policies. The other agenda to be worked on also addresses the reinforcement of knowledge transparency processes based on didactic materials. In other words, scientific communication ways more accessible to communities; be them at school scope, and/or beyond it. These agendas aim at broadening climate governance networks focused on information capable of encouraging the engagement and social articulation of social groups that have suffered with ecological debit impacts in an uneven way.

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