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The Impact of ICTs on Social Actions for Mapping and Restoring Rivers and Streams in the City of São Paulo

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ABSTRACT: As the city of São Paulo grew and developed during the latter part of the 19th century and in the course of the 20th, its approximately 300 rivers were gradually built over, causing them to fade from use and public awareness. Various collectives and social initiatives are now engaged in the rediscovery of these watercourses. Using participant observation and document analysis, we investigated their activities and the impact of information and communication technologies (ICTs) on the process. Our research showed that, in addition to producing, distributing, storing and retrieving information in the digital environment, collectives and social initiatives also play a role in the creation and development of tools and platforms that reveal São Paulo's hydrographic network. We conclude that ICTs allow these activist groups to provide São Paulo's citizens with concrete tools for noticing channelised and buried rivers and streams. We also observe that hybridisation of the physical and digital-informational territories suggests a new way of seeing and occupying the city.

KEYWORDS: Urban rivers, urban collectives, information and communications technology, hybrid territories, São Paulo, Brazil

INTRODUCTION

Under the streets, avenues, houses and buildings that make up the atmosphere of the city of São Paulo hides a hydrographic network of about 300 rivers and streams that have been rectified, channelised and buried (Silva, 2020). Eliminated from the urban landscape and having all but faded from the city's collective memory, São Paulo's buried springs and watercourses have recently begun to be rediscovered, uncovered and restored by various collectives and social initiatives. In the course of their work, these groups of citizens have developed, and are using, digital and networked devices and architectures; this hybridisation of the physical and digital informational territories is effective in suggesting to the city's residents a new way of seeing and occupying the city.

In this article, we analyse six collectives that are active in this process; they include: *Rios e Ruas* (Rivers and Streets), *Rios (In)visíveis* ([In]visible Rivers), *Cidade Azul* (Blue City), *Nascentes SP* (Springs SP), *Existe Água em SP* (There Is Water In SP), and *Volta Pinheiros* (Come Back Pinheiros). These collectives emerged in the mid-2010s and are engaged in the digital production, distribution, storage and retrieval of information about the city's springs, rivers and streams; they are also involved in the creation and development of tools and platforms for mapping these waterways, and integrate systems and services such as augmented reality (AR) and geolocation application programming interfaces (APIs). These technologies are used to communicate and mediate with the city's residents in the unveiling of buried watercourses; they facilitate the reintroduction of these waters to the urban fabric of the city or at least to the collective memory of its inhabitants.

Information and communications technologies (ICTs) are having an increasingly important impact on the redefinition of urban territories and on the mapping of the reappropriation practices of these

territories; this is especially the case with the advent of mobile and location media such as smartphones that are integrated into the Global Positioning System (Gordon and Silva, 2011). These digital-informational devices and systems redefine our actions, habits, displacements and forms of sociability, as well as the interconnections between them. They constitute a new, broader, well-equipped and deeply entangled techno-communication ecosystem.

This study is thus epistemically grounded in the interactions between people, devices and digital and networked architectures, and in the spaces and territories that are, in the process, engendered. Its basic assumption is that the phenomenon under investigation consists of a heterogeneous network that includes social networks (collectives, initiatives and groups of citizens), technological networks (digital devices and architectures), natural networks (waterways and lakes) and urban networks (the structural and architectural dynamics of the city). Social, territorial, communicational and technological experiences are combined in order to promote new forms of sociality and give new meaning to the city's spaces and territories.

The article is divided into three sections. We first approach the historical factors on which the relationship between the city of São Paulo and its watercourses are based. We then discuss how the groups and social initiatives under investigation were analysed and the digital and networked devices and architectures they leveraged. In the final section, we present the main results of the study; they are based on a reading that interrelates the networks, territories and physical spaces of the city with networks, territories and digital-informational spaces. The final considerations synthesise this process and emphasise the growing role of digital and network technologies in the configuration and reconfiguration of urban spatiality and territoriality.

CONTEXT AND RESEARCH PROBLEM

The village that gave rise to the city of São Paulo was founded in 1554 and was situated at the top of a hill that was bounded by two rivers, the Tamanduateí and the Anhangabaú. These rivers were of strategic importance for the colonisers as they formed a natural obstacle to any Indigenous group hostile to the presence of Portuguese invaders and constituted a vantage point from which the invaders could observe the movement of Indigenous groups and quickly mount a defence from possible attacks (Zagni, 2004). The Tamanduateí River was also the main route connecting the interior and the coast and was used to transport people and goods. During the first centuries of colonisation, the river was one of the few places of leisure and entertainment for the residents of São Paulo (Taunay, 1951). During this period, however, the relationship between the city and the Tamanduateí deteriorated; garbage was dumped on its floodplains and its natural course was diverted in order to suit the convenience of the city's inhabitants (Bartalini, 2006).

The first water diversion conduits were built in the mid-18th century, supplying piped water that fed public fountains, spouts, springs and tanks (Bruno, 1991); already by that point, the quality and quantity of water in São Paulo was compromised. According to Gouveia (2016), however, it was not increased demand that produced water scarcity; considering the slow population growth in the first three centuries of colonisation, the shortage of water is more likely to have resulted from the physical changes in the use and occupation of the area, which altered the hydrological cycle itself.

São Paulo entered the 19th century, paradoxically, trying to solve the problem of the scarcity and poor quality of drinking water with the rectification, channelisation and buffering of its rivers and streams. The 1867 construction of the Santos-Jundiaí Railroad – the São Paulo Railway – represented an important milestone in this process. In general, railroads had a great impact on the organisation and structuring of the city; they became the points on which a new and conflicting sociospatial arrangement was developed, with lands adjoining the railway lines going up in value and thus arousing the interest of investors. Building the electrical grid was also a crucial factor in the urbanisation and transformation of rivers, streams and floodplains (Seabra, 1987). Another powerful influence on this process was the hygienist

discourse and the desire to transform the city into a capital that was favourable to the interests of growing real estate speculation (Sant'Anna, 2007).

Between the end of the 19th and the beginning of the 20th centuries, the 'coffee metropolis' thus developed as a modern, industrial city which neglected its rivers and streams and transfigured its natural landscape. This was further aggravated by road development and the Avenues Plan, a structural road system project that led to the appropriation of river networks to build the city's main traffic routes. Rivers and streams were confined into channels or underground galleries and the so-called valley-bottom avenues were built on their former beds. This association between the construction of avenues and the channelling of rivers and streams completed a circulation model that was centred on the private car; this has prevailed until the present (Rolnik, 2001).

When investigating this relationship between the city of São Paulo and its hydrographic network, Seabra shows how, in the modern era, the modalities of use of urban space not only obey the particularities or specific properties of places; they also follow what the author defines as, "historical forms of the social process in modernity". Seabra adds that, as a result of this conflicting relationship, "the different attributes of the urban space, whether derived from nature, culture or history, are immediately translated in terms of exchange value" (Seabra, 2012: 288-289).

Whether these watercourses are visible or trapped in underground channels, they present us with elements that reveal not only the natural landscape of São Paulo, but also the economic, political, cultural, social and environmental choices according to which the largest city in the southern hemisphere and the richest city in Latin America was built. The urbanisation of rivers and streams is not a process exclusive to São Paulo, but rather is characteristic of other important modern metropolises and megalopolises. Effective policies aimed at renaturalising these river systems and re-establishing the natural hydrological cycle are observed in countries in Europe, Asia and America (Findlay and Taylor, 2006; Everard and Moggridge, 2011; Castonguay and Evenden, 2012); however, the absence of such policies in São Paulo places the city in a backward situation.

It was only in 2002 that the City of São Paulo's Strategic Master Plan,¹ in one of its guidelines, called for the implementation of parks and green areas that coincided with the so-called structural water network, that is, with rivers and their first-, second-, or third-order tributaries (Bartalini, 2006). This innovative policy for the recovery of rivers and streams has the potential to inaugurate a new paradigm in the management of water resources in the city, one that is in line with what has been developed in other countries; however, almost two decades after its formulation, no measures have actually been implemented.

According to Sánchez and Jacobi (2012), the explanation for the poor implementation of any policy for the recovery of rivers and streams in the city of São Paulo can be found in the municipal political dynamic itself. For the authors, the government has shown itself to be incapable of developing long-term policies such as environmental programmes; instead, it succumbs to the hegemony of the market and neglects plans and laws for regulating and defining urban interventions. Non-compliance with a decentralised and participatory municipal management model also contributes to the weakening of integrated and sustainability policies, including those pertaining to river and stream recovery.

Not even the 2014 water crisis – the worst ever experienced by the population of São Paulo – changed this scenario. It has been stated, in fact, that this crisis was not only the result of climate change and the lack of rain in the summer of 2013/2014; many feel that it was also a product of the inertia of water governance agents and institutions. This refers specifically to Sabesp, the Brazilian water and waste management company of whom the state of São Paulo is a major shareholder. Sabesp provides water and sewage services to residential, commercial and industrial users in São Paulo, typically under 30-year contracts (Coutinho et al., 2015). The hegemony of Sabesp contradicts the *Política Estadual de Recursos*

¹ The Strategic Master Plan is a municipal law that guides the development and growth of São Paulo until 2030.

Hídricos (State Water Resources Policy, or PERH), a 1991 law that proposes a decentralised, integrated and participatory water management system, instead of institutionally fragmented management (Jacobi et al., 2015).

Parallel to this lack of strategic planning and the weak socio-environmental commitment of government institutions, there is an increase in the number of associations and citizens groups that are engaged in discussions and strategies related to water governance and restoration of rivers and streams, especially in the state capital. These groups are driven mainly by an awareness of the impact of anthropic actions on ecosystems; however, advances in the field of ICT have enabled the emergence of new forms of organisation and social participation (Castells, 2012), including in the water sphere (Hernández-Mora et al., 2015; Pedregal et al., 2015; Rothberg, 2015; Silva, 2020). With regard to the collectives and social initiatives presented in this study, these technologies expand the possibilities for accessing, producing and sharing information; as further discussed in this article, these technologies have also enabled new spatial articulations.

FIELD OF INVESTIGATION AND METHODS

The study used participant observation and document analysis as qualitative data collection methods. We initially mapped the collectives and social initiatives engaged in the phenomenon under investigation, the devices and the digital and network architectures used by them, and the spaces and territories through which they circulated. We also immersed ourselves in the physical territory of the city of São Paulo in order to investigate the interactions between the agents of this process. We specifically considered: interactions among people, people's interactions with the city, and people's interactions with digital and networked devices and interfaces.

From January 2018 to December 2019, we used participant observation to conduct continuous and detailed monitoring and recording of the activities and urban experiences being undertaken by the investigated collectives; these included expeditions through the city, workshops on mapping and localisation of rivers and streams, artistic interventions and exhibitions, traveling cultural shows, and task forces for revitalising springs. Capturing this data in real time made it possible to construct dynamic and contextual knowledge about the phenomenon. One of the methodological principles of participant observation is to present information produced by the researchers in a way that can be easily assimilated by the researched groups. This research method has thus always been effective in studies on popular and social movements and initiatives, as well as in studies on communities and small groups, and can even serve to assist groups in making future choices and actions (Borda, 1981; Peruzzo, 2005).

This process of immersion in the spaces and territories of the city in which the collectives develop and share their activities can be equally defined as a "conscious and systematic sharing, in so far as circumstances allow, in the life-activities and, on occasion, in the interests and affects of a group of persons" (Kluckhohn, 1940: 131). All information collected during this period was also regularly recorded in detail in a field journal and was later organised and descriptively analysed.

We simultaneously carried out a document analysis, which continued until early 2021. This included the identification, verification and appraisal of documents, and helped in the contextualisation of facts, situations and moments (Moreira, 2005). In the context of the study, these documents consist of textual production and of sound, image and audiovisual recordings that were produced and made available by collectives and social initiatives on their respective websites, interactive platforms and digital social networks.

The collectives were thus considered to be acting as producers of information and content about São Paulo's rectified, channelised and buried rivers and streams and the possibilities of restoration of the city's hydrographic network. This body of information was also assumed to be a digital repository of the history and memory of those waters. All the collectives had emerged only since the mid-2010s; tracing

their steps and the connections they engendered in the digital environment thus also served to delineate their own trajectory.

Based on the collected empirical data, we were able to apprehend the main characteristics of the different ways of being and living in the world that make up the investigated phenomenon. This led to a perspective that was built methodologically and was based on experience, proximity, participation and correspondence with the other; the 'other' could be either a waterway that had been built over, or the technology that unveiled it. This involved describing the actions and associations between human and non-human entities, with the aim of showing how the latter can offer us material for reflection. Considering the non-human elements in the relationship with territory can be particularly useful in an examination of the central dimensions of the conditions of living-with (Maffesoli, 2017; Silva, 2019).

In this sense, the methodology of the study permeated its epistemological issues, particularly as related to communication processes and understanding of technologies. Because of the dynamics of the collectives, it was necessary to become immersed in the city and occupy it in order to know its hidden sides; at the same time, it was important to immerse ourselves in the digital platforms used and/or developed by the collectives and in that way to follow their flows and learn how to see the city through these digital architectures.

EMPIRICAL ANALYSIS AND MAIN RESULTS

The collectives and social initiatives that are engaged in the mapping and restoration of São Paulo's rectified, channelised and buried rivers and streams are active in creating, distributing, storing and retrieving information in the digital environment. They also help create and develop digital and networked devices and architectures; these include, for example, collaborative and interactive maps, audio guides connected to apps with geolocation, and smartphone games based on geolocation and augmented reality that allow users to discover the hydrographic network of São Paulo. Table 1 shows the overlap between the performance of these groups in the digital environment and their performance in the physical territory of the city.

Table 1. Corpus of empirical observation.

Urban collectives	Activities, projects and technological resources utilised
<i>Rios e Ruas</i> (Rivers and Streets)	<p>Conducts periodic urban expeditions to explore the rivers and streams of the city of São Paulo as well as the springs and mouths of these water courses; promotes practical and theoretical workshops, sports and leisure activities, cultural exhibitions, urban interventions, and artistic exhibits such as the interactive media – art exhibition <i>Rios des.cobertos – O resgate das águas da cidade</i> (Un.covered Rivers – Rescuing the City's Waters); develops a project called <i>Affective Map of São Paulo's Springs</i>, an interactive digital map of São Paulo's springs and watercourses built in a collaborative way and described as "social and affective"; manages a blog, a website, as well as a Facebook page and profiles on Instagram, Twitter and Soundcloud; altogether, these digital social network profiles have approximately 32,000 followers.</p> <p>(See facebook.com/rioseruas; instagram.com/rioseruas; twitter.com/rioseruas; youtube.com/RioseRuas; soundcloud.com/rios-e-ruas; rioseruas.wordpress.com; mostrarrioseruas.com.br)</p>

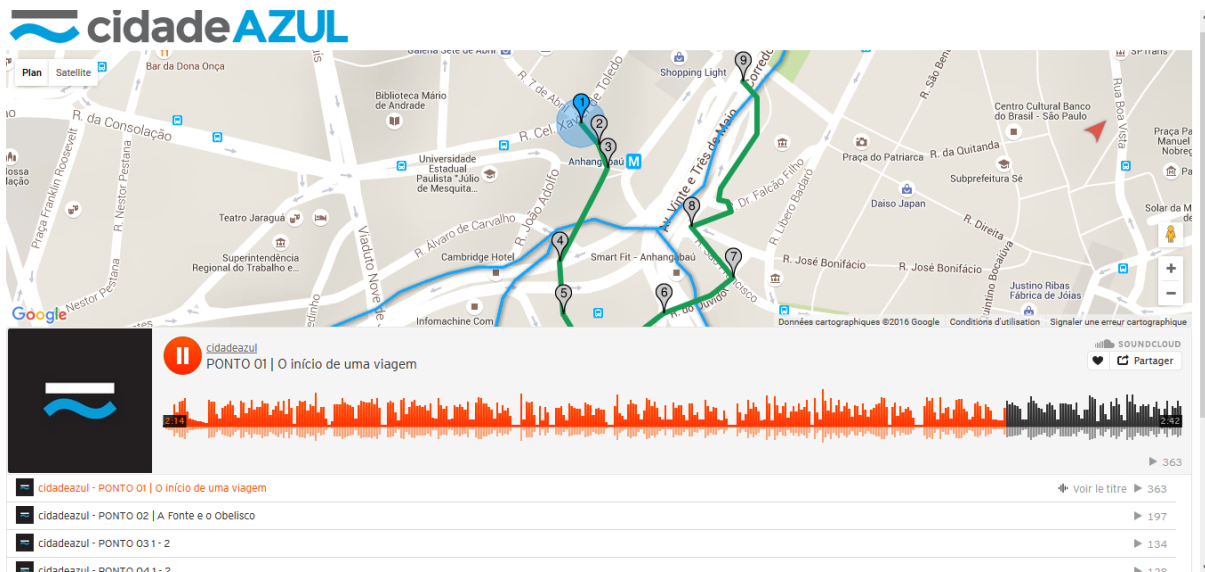
<i>Cidade Azul</i> (Blue City)	<p>Develops audio guides connected to digital maps, which allow users to follow the path of buried rivers and streams in São Paulo; manages a website, a Facebook page, an Instagram and Pinterest profile, a Twitter account and a YouTube channel; promotes actions in city schools, including the <i>Missão Cidade Azul nas Escolas</i> (Cidade Azul in Schools Mission), and cultural festivals such as the <i>Festival Cidade Azul: Celebrando a água através da arte, da tecnologia e da inovação</i> (Cidade Azul Festival: Celebrating water through art, technology and innovation); currently developing two audiovisual productions and a game for smartphones based on augmented reality and geolocation, which will allow users to follow the flow of water courses and will address issues around the conscientious consumption of water and sewage treatment; has a total of about 5000 followers in digital social networks.</p> <p>(See soundcloud.com/cidadeazul; cidadeazul.org facebook.com/acidadeezul; instagram.com/acidadeazul; br.pinterest.com/cafenarua/cidade-azul-the-blue-city; youtube.com/c/CidadeAzulChannel; twitter.com/acidadeazul)</p>
<i>Rios</i> (In)visíveis ([In]visible Rivers)	<p>Responsible for the ideation and creation of the first interactive and collaborative digital map of São Paulo's channelised and buried springs, rivers and streams; the map was developed with the help of MapBox and Collective Maps tools, and used data from the Master Plan for Drainage and Management of Stormwater for the City of São Paulo (PMAPSP); the group also runs a Facebook page with approximately 2000 followers.</p> <p>(See www.riosdesaopaulo.org; web.facebook.com/riosinvisiveis)</p>
<i>Nascentes SP</i> (Springs SP)	<p>Carries out research, mapping and social awareness of São Paulo's buried rivers and streams; monitors and disseminates information about the quality of water from urban springs and the possibilities for using this water, and carries out joint efforts to revitalise springs; manages a Facebook page with over 2000 followers and a Facebook community called <i>Hortelões das Nascentes</i> with more than 700 members.</p> <p>(See facebook.com/NascenteSP; facebook.com/groups/horteloedasnascetes)</p>
<i>Existe Água em SP</i> (There Is Water in SP)	<p>Shares daily texts, photographs and videos on Facebook of springs, rivers and streams that are ignored by the inhabitants of São Paulo; registered more than 100 springs in the first years of the project in several central and peripheral regions of the city, some of which were also revitalised; among the revitalisation projects, we highlight the project carried out in partnership with the collective <i>Ocupe e Abrace</i> (Occupy and Hug) at Praça da Nascente (Praça Homero Silva) located in the Pompeia region in the West Zone of São Paulo, and another in partnership with the Guarani people of the Indigenous territory Tekoa Itakupe, located in Jaraguá's north side; this relationship between the collective and the Guarani is also evident on the Facebook page <i>Existe Guarani in SP</i> (There Is Guarani In SP) and, together, the 2 pages have more than 30,000 followers. (See facebook.com/existeaguaemsp; facebook.com/existeguaraniemsp)</p>
<i>Volta Pinheiros</i> (Come Back Pinheiros)	<p>Movement for the revitalisation of the Pinheiros River, located in the West Zone of São Paulo; uses websites and social media such as Facebook (with almost 5000 followers) to disseminate information and content about the river; promotes online petitions and other informational and organisational actions on digital networks.</p> <p>(See voltapinheiros.com.br; facebook.com/voltapinheiros; https://bit.ly/3WEpVyJ)</p>

Source: Research field notebook.

In our observation, all urban activities and experiences offered by the investigated collectives are characterised as moments in which their founders meet with people who are either directly active or not

in these groups, to explore the streets, spaces and territories of the city; this activity is usually mediated by technological and digital resources. As they are freely available online, the platforms and applications developed by the collectives also allow anyone who has a tablet or smartphone with internet access to use these tools as they explore the city and its hidden and visible waterways. This is the case for the audio guides developed by the *Cidade Azul* collective,² which allow users to independently follow the path of buried rivers and streams just by following the narrators' voices and the map available on their website, created based on the Google Maps mapping service (Figure 1).

Figure 1. Audio guide, The meeting of rivers.



Source: <https://www.cidadeazul.org/>

This platform, like others investigated in this study, suggests a connection between users, the city of São Paulo, and digital and networked devices and architectures; through their interaction, they reveal social, technological and environmental elements. In an excerpt from the digital audio guide for the route of the completely channelised and buried Rio Verde, it is possible to observe a connection between humans, territory and technology; the group also attempts to unveil or rediscover a hidden nature that has been forgotten by the city and by many of its inhabitants:

You are now at the exit of the Vila Madalena subway station and probably cannot see any rivers at all. I will try to help you. Look around you. Turn onto the noisy avenue next to you, Heitor Penteado. Can you see the horizon? Which side shows more sky? Which side shows less sky? Where you see little sky, it is because you are looking towards the side of the hill. Where you see a lot of sky, you are looking at the Valley, the side the water flows to. That's where we're going. Now, something important: we need you to open your senses. From now on, pay attention to the sounds, smells, colours, air temperature, signs of the living river that is flowing under our feet. Also look for the posts painted in blue that will help guide your tour. Now pay attention! We will leave the subway station exit behind us and walk straight ahead until we leave the station. Afterwards, we'll continue straight along Rua João Moura, on the sidewalk on the right, until we reach the corner with Rua Iperó, and don't forget: always going downhill (Audioguide Cidade Azul/Rio Verde).³

² Retrieved from <https://soundcloud.com/cidadeazul>

³ Retrieved from <https://soundcloud.com/cidadeazul/sets/cidade-azul-rio-verde>

The mobile game *Blue City Mission*, still under development by the *Cidade Azul* collective, also intends to offer this type of technology-mediated experience of the city. The game is based on the concept of watch-and-play, augmented reality and geolocation. It allows its users to map the flows of watercourses while addressing issues around sewage treatment and the conscious consumption of water; it also presents what the creators call ancestral themes, that is, those linked to the natural geography of the region and to the Indigenous peoples who inhabited it before the Portuguese invasion and colonisation.⁴

We also observe that the collectives, by connecting the physical territory of the city to the digital environment, seek to provide the social imagination with concrete elements for the perception of channelised and buried rivers and streams; in this way, they propose a new way of seeing and occupying the city. The image in Figure 2 was captured during an urban expedition carried out in a collaboration between the *Cidade Azul* and *Rios e Ruas* collectives; it aptly illustrates this movement of reappropriation of urban public space. According to the project's developers, what the people in the image observe and touch are signs of one of the countless rivers and streams that run invisibly under São Paulo. The small watercourse runs through a gutter which is easily mistaken for a sewer; it reveals itself to the expedition's participants through the digital architectures for mapping and describing the paths of these waters.

Figure 2. Urban expedition carried out by the *Cidade Azul* and *Rios e Ruas* collectives.



Source: <https://www.facebook.com/rioseruas/photos>

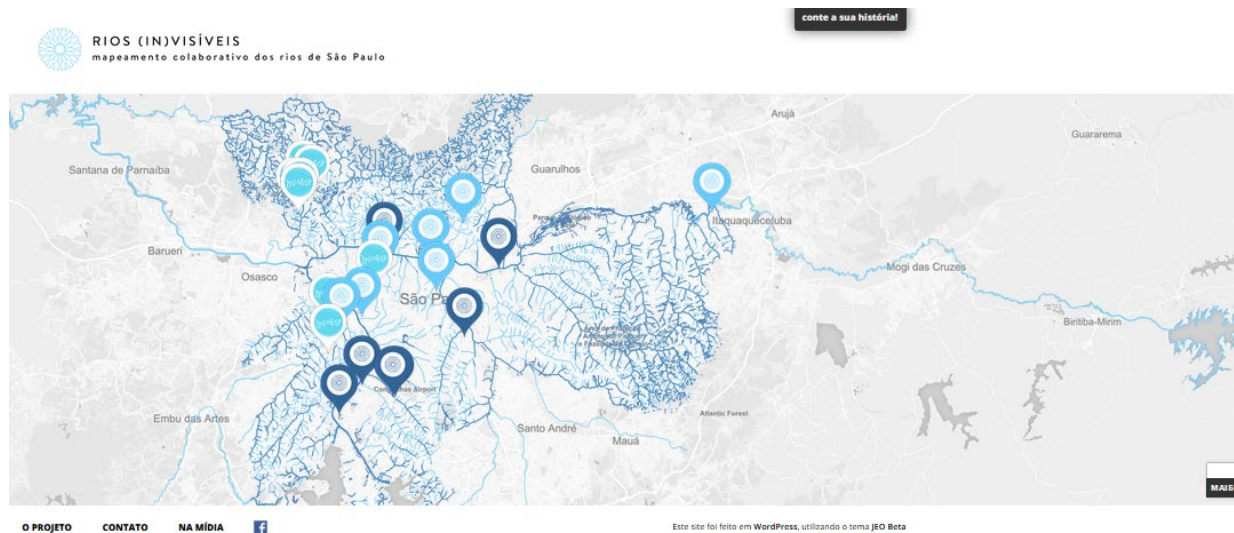
Other experiences, such as interactive and collaborative digital maps of underground streams and rivers, do not have to take place in the city's actual territories. Through the platform developed by the *Rios (In)visíveis* collective (Figure 3), anyone can share stories about the city's watercourses or record their personal memories: "The idea is that the narratives take place in first person, so that the reader can reflect on their relationship with these watercourses".⁵ In developing the platform, the group used data

⁴ Retrieved from <https://www.cidadeazul.org/>

⁵ Retrieved from <http://www.riosdesaopaulo.org/>

from the Master Plan for Drainage and Management of Stormwater for the City of São Paulo (PMAPSP) and relied on tools such as MapBox⁶ and Mapas Coletivos.⁷

Figure 3. Collaborative map developed by the *Rios (In)visíveis* collective.



Source: www.riosdesaopaulo.org

Each point highlighted on the map tells a story or shares a memory of this network of rivers and streams. In addition to this platform, other interactive and collaborative digital projects are being developed such as the *Mapa Afetivo das Nascentes Paulistas* (Affective Map of São Paulo's Springs). This was conceived by the *Rios e Ruas* collective, whose idea is to carry out a "social and affective mapping of the springs of these watercourses, through various forms of narratives and expression, such as testimonies, music, photos, videos, texts, and other productions that can be developed and published by the people who live near these springs".⁸ This process of mapping springs and sharing information about them, with texts, photographs and videos, can also be observed in the social media accounts of initiatives such as *Nascentes SP*⁹ and *Existe Água em SP*.¹⁰

The art media exhibit *Rios des.cobertos – O resgate das águas da cidade* (Un.covered Rivers – Rescuing the City's Waters) was developed by *Estúdio Laborg*¹¹ in partnership with the *Rios e Ruas*¹² collective. Through interacting with this technological resource, visitors can perceive images of rivers and streams, 'unhiding' them. The exhibit consists of a mapped and interactive projection over a model of watercourses in the city of São Paulo and is executed in 3D technology (Figure 4).

⁶ Retrieved from <https://www.mapbox.com/>

⁷ Retrieved from <http://www.mapascoletivos.com.br/>

⁸ Retrieved from <https://rioseruas.wordpress.com/mapa-afetivo/>

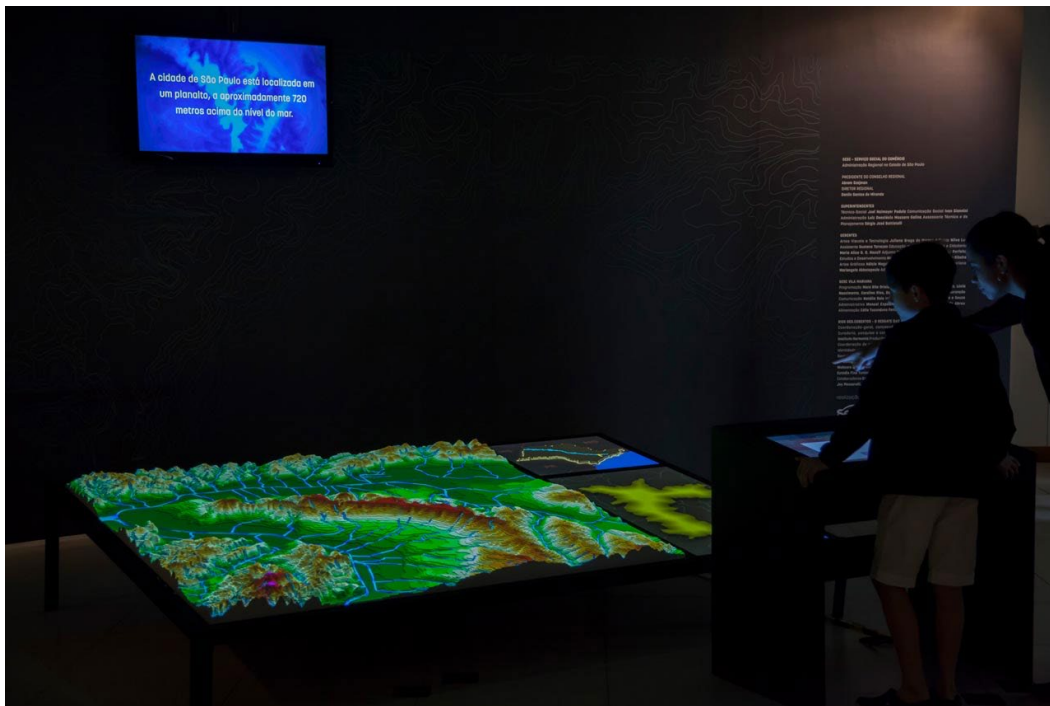
⁹ Retrieved from <https://web.facebook.com/NascenteSP/>

¹⁰ Retrieved from <https://web.facebook.com/existeaguaemsp/>

¹¹ Retrieved from <https://www.estudiolaborg.com.br/>

¹² Retrieved from <http://rioseruas.com.br/>

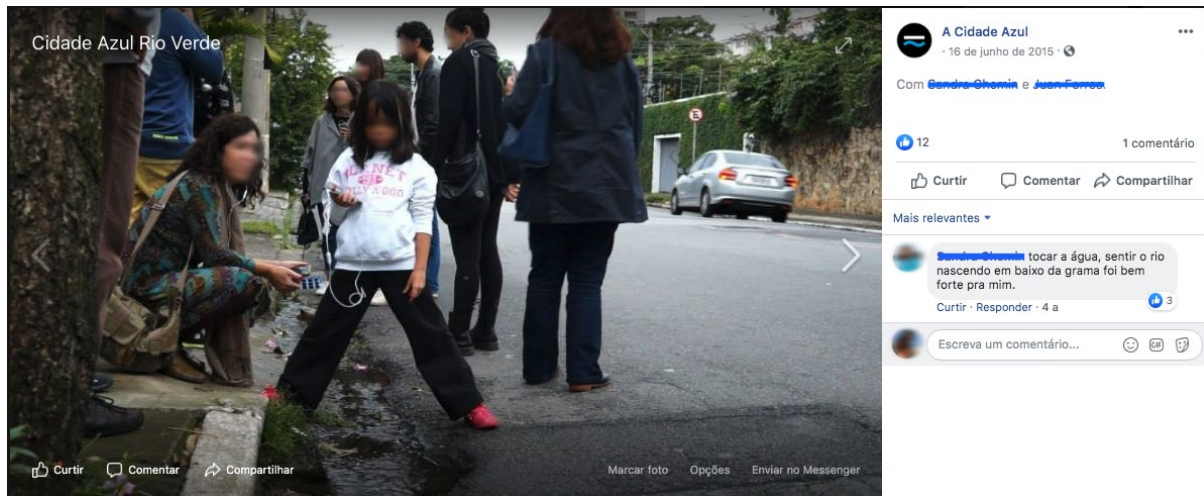
Figure 4. Art media exhibit, *Rios des.cobertos – O resgate das águas da cidade* (Un.covered Rivers – Rescuing the City's Waters).



Source: www.estudiolaborg.com.br/portfolio/rios-des-cobertos-o-resgate-das-aguas-da-cidade/.

As highlighted, the interrelation between the collectives and social initiatives that we investigated and the information and communication technologies they used does not just happen through sharing information about watercourses on websites, in blogs and on social media; the interaction is also manifested in the very form of the devices and the digital and network architectures that are used and developed by these groups, which are ubiquitous in the current communications and technology environment. These groups already show the capacity to leverage technology in their efforts to reintegrate São Paulo's hydrographic network into the urban fabric of the city or at least into the collective memory of its inhabitants. We thus focus our analysis on several types of technology that are being developed for use, including, 1) the incorporation of audio guides and digital maps into the tracing of buried rivers and streams; 2) collaborative digital platforms for mapping springs, rivers and streams; 3) an interactive exhibit based on 3D technology; and 4) a smartphone game based on the watch-and-play concept, augmented reality and geolocation.

Digital and networked technologies constitute a new media and high-tech communications ecosystem. Their incorporation into physical spaces and their capacity to modify people's behaviour are characterised by mobility, portability and connectivity. Weiser (1999: 3) notes that "the most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it". Thinking based on these technologies therefore means thinking based on their connections, associations and interconnections. This is exemplified in the visualising of watercourses that is possible thanks to platforms, and in the meanings that emerge through these experiences. Figure 5 shows an image that was published in 2015 on the *Cidade Azul* collective's Facebook page during one of the group's first actions. One of the participants in their urban expeditions commented that "touching the water, feeling the river sprouting from under the grass was really powerful".

Figure 5. Screenshot from the *Cidade Azul* collective's Facebook page.

Source: <https://www.facebook.com/acidadeezul/photos>

This is what lies at the core of our interpretation of this phenomenon as a network of social, technological, environmental and urban networks. The technologies and people that participate in the observed phenomenon are not static entities, disconnected from the physical space into which they are inserted; rather, they are part of networks that are formed by links built from person to person, people to technologies, people to territories, and technologies to territories. As stated by Milton Santos (2017), notions of technique and environment are equally inseparable, with the latter being understood as more than the idea of natural surroundings. Technique itself can also be considered as an environment and the geographical space as a technical-scientific-informational medium. According to the author, "space is a mix, a hybrid, a composite of form-content" (ibid: 42).

What information and communications technologies in their mobile form do is document and complexify this hybridity. ICT devices and architecture have become increasingly embedded in the territory we inhabit. This includes – paradoxically – their use in the exploration of natural resources for their own manufacturing, functioning and disposal, as well as their role in creating and connecting spaces and territories. They expand and equip our daily lives, changing everything from our everyday dislocations to the very way we see the city. As noted by Lemos (2016: 18), "never have objects and data had such independence, performativity, communicability, and agency as in contemporary society".

Indeed, these objects, things or non-human entities articulate new sociabilities, territorialities and spatialities; they possess a quantitative and qualitative variability that appears in their extensions to all dimensions of social life. In the case of the phenomenon under study, a continuum is observed in the hybridisation of the city's physical territories and the digital-informational territory of the devices and architectures that help reveal the watercourses of São Paulo. This continuum is also observed in the relationships between people, technologies and places; these are coming to be constituted as networks, or more specifically, as network-movements that are characterised by connections, associations and socio-techno-environmental flows.

FINAL CONSIDERATIONS

This paper sought to investigate the impact of information and communication technologies (ICTs) on the actions of social collectives and initiatives currently engaged in un hiding the approximately 300 watercourses that have been rectified, channelised and buried in the city of São Paulo. The six groups

that we analysed emerged in the mid-2010s; they combined activities and experiences developed in the physical environment of the city with activities and experiences developed digitally. Based on our analysis of the groups and of the digital and networked devices and architectures they use and leverage, we were able to trace and describe interactions among people, technologies and the city's physical spaces and territories.

The notion of network appears in the study as movement, record of movement and shape; however, it is not a shape that is fixed or finished, but rather is fluid, moving and unfinished. This means that the networks of people, technologies, rivers and streets that make up the investigated phenomenon form, in turn, a heterogeneous network in which every element or entity is interrelated. By allowing for the mapping and visualisation of hidden watercourses, the network in its technological and digital form allows for the unhiding of these watercourses in people's imaginaries. This process can be a first and important step in the reinsertion of these waters into the urban fabric of the city.

At the same time, we were able to verify a continuum of hybridisation between the city's physical and its digital-informational territories. The reading of technology as a simple mediator between people and hidden rivers/streams could thus be expanded into a view of these technologies as being embedded in the city and its people, thus establishing a new socio-techno-environmental ecosystem. In this sense, the digital landscape blends into that of the city, resulting in a hybrid landscape that is also interactive, interconnected, hypercommunicative and hypermediated.

Indeed, this paradigmatic inflection follows a previous shift in the materiality of digital and network technologies themselves, which, thanks to the rise of mobile and networked devices and technologies, allowed for larger connections among people, things and places. This resulted in the phasing out of the idea of a 'virtual' world that was distinct from the 'real' world, and continuously integrated technology to daily life in all its conflictuality. In short, digital and network technologies, together with their interfaces and devices, have been transforming our concepts of space and territory.

As mentioned above, these technologies are being mobilised by São Paulo's collectives and social initiatives to create, distribute, store and retrieve information about channelised and buried rivers and streams, and are also being used in the mapping and visualising of these watercourses. It is in this sense that ICTs have a direct impact on the actions of these groups. They allow people to gather around socio-environmental issues, conveying a precise spatiality with regard to the location of the hidden watercourses and instilling a sense of urgency around their reinsertion into the urban landscape. Through the platforms described here, ICTs play a fundamental role in the perception of these rivers and streams; they also help build and update a collective memory that constitutes a factor of engagement (Rothberg, 2015). ICTs also reverberate in the concrete experiences of renaturalisation of springs all over the central and peripheral regions of the city of São Paulo (Silva, 2016; 2020). Such reverberations can be assumed even in movements such as the one currently under discussion in São Paulo City Hall which demands the creation of Parque do Bixiga and the restoration of the part of the Bixiga River that is buried under the streets of the traditional Bixiga district. The active presence of the studied groups in this movement and the use of digital and networked devices and architectures make this connection particularly clear.¹³

Even if certain institutions or entities involved in São Paulo's water governance appear as partners and collaborators in activities, they play no formal mediating role. Notably, the initiatives that are born from the meeting of common citizens around a common interest are not acting in an attempt to manage the city's waters; rather, they are engaged in a true process of remembering with, and through, information and communication technologies. Each document, photographic record and historical narrative about the hydrographic structure of the city is fundamental to this process and also to the creation of new narratives that circulate in digital networks in the form of, for example, texts, hypertexts, images, sounds, videos, graphs and infographs.

¹³ Retrieved from <https://linktr.ee/parquedobixiga>

When thinking about the influence of these technologies on acts of hydro-citizenship, we should consider the constraints as well as the affordances of their use (Hernández-Mora et al., 2015; Mukhtarov et al., 2018; Pedregal et al., 2015). However, leaving behind a merely instrumental line of thinking and aiming for a relational approach, we can observe the importance of leveraging these technologies with which we interact and coexist. As shown in our empirical description, the actions of the collectives and social initiatives we investigated are, indeed, intrinsically attached to these technologies; at the same time, however, they are not limited to them. The groups are also innovative in expanding their activities to urban territory and inviting people to know this territory and to give it new meaning as they occupy it. Hydrologic action is thus also an extension and complexification of the physical territory from the digital-informational territory and vice versa, thus highlighting the idea of technique and environment as indissociable.

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