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JARDIM PANTANAL: A INSTRUMENTALIZAÇÃO DE UMA BACIA HIDROGRÁFICA

JARDIM PANTANAL: INSTRUMENTING A HYDROGRAPHIC BASIN

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Abstract

The urbanization process of Latin American metropolises resulted in a fast expansion of precarious settlements on their outskirts, deprived of basic sanitation infrastructure. The floodplains in metropolitan peripheries in Latin America became the stage for a clash of conflicting vectors: the large public works to contain floods, the search for housing, and the required protection of the environment. This article seeks to reconstitute the work carried out by researchers and residents, since 2015, regarding the appropriation of Jardim Pantanal, a stretch of the Tietê River floodplain in the city of Sao Paulo, State of São Paulo, in Southeastern Brazil. The project proposes the transformation of a critical urban area, with wide urban and environmental degradation, into a better place to live. This operation is carried out through surveys, mapping, and monitoring of the hydrographic basin. The ZL Vortice project aggregates several research laboratories, in collaboration with residents, to develop socially inclusive and sustainable technologies of water management and urbanization, specifically designed for critical situations. The hydrographic basin's instrumentation consists of the following problem: How to take technologies conceived in laboratories to the floodplain? Our answer is to transform the floodplain into a laboratory. The article presents the investigative processes carried out, the activities performed by

researchers with the community, and the projects proposed to agencies that formulate public policies. It also includes the work involved in the modeling of the area and the elaboration of maps and scale models, tested in field expeditions with the residents. The ZL Vortice project's proposals dialogue with projects developed in several Latin American cities — the theme of this edition of V!RUS magazine. The project is indicative of the intense research made in the region on inclusive and low-cost technologies, specific to local conditions, seeking to reverse environmental liabilities and urban inequalities.

Keywords: Laboratory, Floodplain, Instrumentation

1 Introduction

The urbanization process in Latin American metropolises has caused a fast expansion, in their outskirts, of precarious human settlements deprived of basic sanitation infrastructure. The disorderly growth of the urban occupation has impacted, for example, floodplain areas and water sources in São Paulo and *chinampas* in Mexico City, both essential for the preservation of hydric resources in these metropolises. Floodplains in metropolitan peripheries of Latin American cities thus became the stage for a clash of conflicting vectors: large public works for containing floods, the need for housing, and the required protection of the environment. This paper seeks to reconstitute the work carried out by researchers and residents of appropriating the area named Jardim Pantanal (Jardim Helena District, sub-prefecture of São Miguel Paulista), a stretch of the Tietê River floodplain, in the East Zone of the Municipality of São Paulo, State of São Paulo, in Southeastern Brazil.

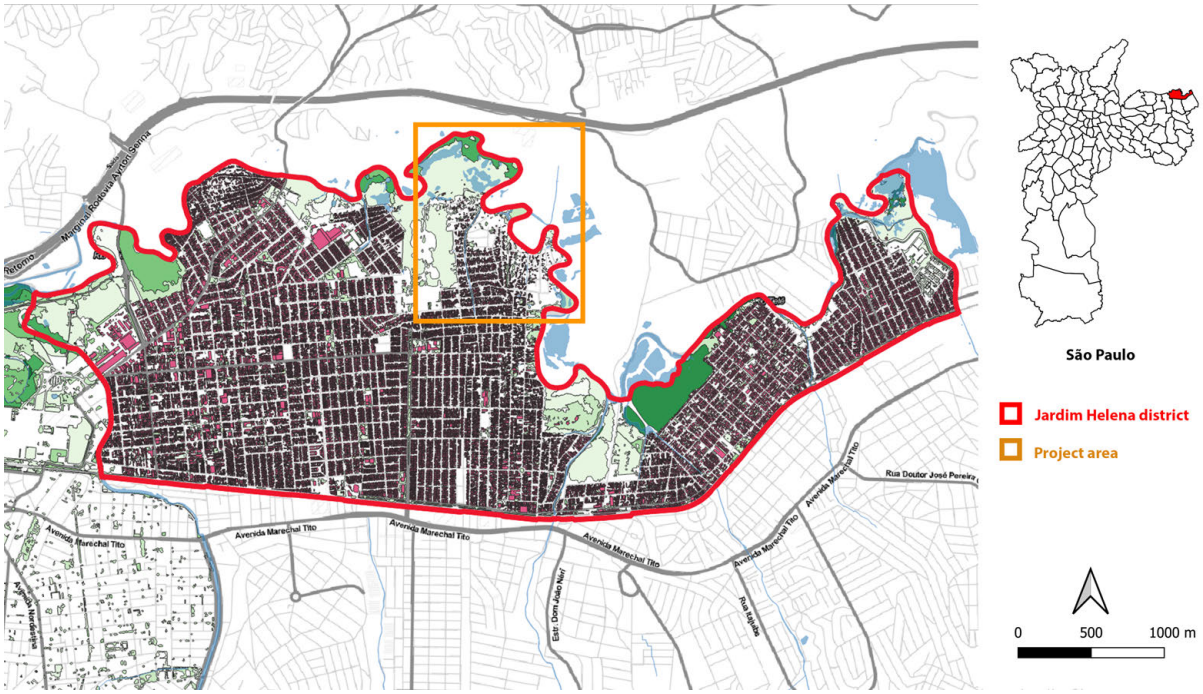

Fig. 1: Administrative map of Jardim Helena's neighborhood and the area of the project. Source: Authors, 2021.

Fig. 2: Map of the hydrographic basins covered by the ZL Vortice project. Source: Authors, 2021.

The area of the project covers three hydrographic basins in the Municipality of São Paulo, enclosed in the Upper Tietê Basin: the São Martinho Creek Basin and two areas that directly contribute to diffuse flow, along the Tietê River. The ZL Vortice project proposes to transform a critical urban area, of wide urban and environmental degradation and subject to constant flooding, into a better place to live – an operation promoted through surveys, mapping and monitoring of the watershed. The project aggregates several research laboratories, in collaboration with the Jardim Pantanal Residents Association (AMOJAP), to develop socially inclusive and sustainable technologies of water management and urbanization, specifically designed for critical situations.

The process of appropriating the territory, through the instrumentation of the hydrographic basin, has been carried out in several stages, from 2015 until today. The initial visits were land inspection incursions, essentially exploratory. Residents led investigators to the areas they considered most problematic, resulting from siltation of watercourses and landfilling. Those first expeditions confronted the researchers with the extreme conditions of the Tietê River floodplain in the city of São Paulo, highlighting the need for an analytical repertoire and specific operational tools to face situations on the edge of urban and environmental collapse.

Fig. 3: Visits to occupied areas (03/26/2016) and landfills (12/11/2017) on the Tietê River banks. Source: ZL Vortice Project, 2017. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

2 Strategy: interaction with public projects

The strategy initially adopted by ZL Vortice consisted of searching interlocution with public projects that showed sustainable and inclusive policies for the floodplain. The União de Vila Nova neighborhood, a development project by CDHU (São Paulo State Housing and Urban Development Company), was implemented in the first stretch of the floodplain and is occupied by precarious settlements. In the stretch, besides the rectification of the river, the project involved the construction of a circumvallation canal, a

drainage system consisting of channels and a park, and whose maintenance requires the residents' collaboration along with the support of public facilities for environmental preservation and waste recycling. In União de Vila Nova, the strategy outlined the implementation of infrastructure with social participation, which was something we systematically sought to develop in Jardim Pantanal.

The ZL Vortice project carried out seminars and technical visits with professionals from public agencies operating in the Tietê River floodplain: in addition to CDHU, Emplasa (São Paulo Metropolitan Planning Company), and SIMA (State Secretariat for Infrastructure and Environment). The process allowed us to take stock of the public policies oriented for the area, identify its main agents and propose complementary projects. As a guideline, the ZL Vortice project adopts the geomorphological and hydrological survey presented in the Management Plan of the Environmental Protection Area of the Tietê River Floodplain (APA VRT), recently completed by the Forestry Foundation (SIMA).

Fig. 4: Seminar on Jardim Pantanal at CDHU (2014) and presentation of the APA VRT Management Plan (2015). Source: ZL Vortice Project, 2017. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

We also held workshops with CDHU technicians and residents of União de Vila Nova about projects dedicated to the consolidation and maintenance of public spaces. The proposals included the design of the sidewalk around the park, the urban furniture made of adobe for the drainage channels' margins, and a project to reuse materials, in a partnership with the local recycling cooperative.

Fig. 5: Regina Silveira, project for Central Park and posters, União de Vila Nova. Source: ZL Vortice Project, 2019. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

Fig. 6: Elisa Bracher, Adobe modules for streams and drainage channels maintenance. Source: ZL Vortice Project, 2019. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

Fig. 7: Beto Paiva, materials reuse workshops (2015). Source: ZL Vortice Project, 2019. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

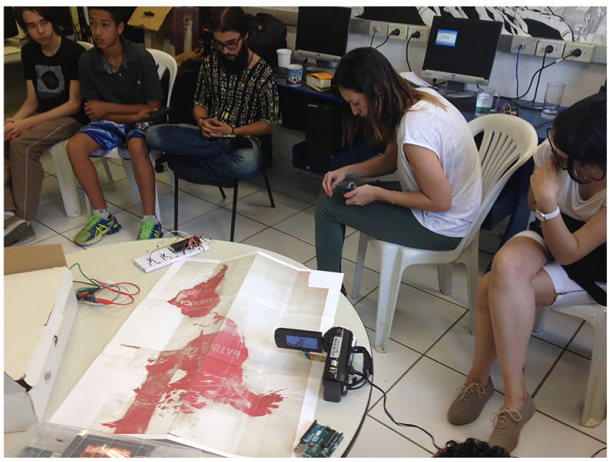

Fig. 8: Marcos Bastos and Samanta Fluture, sensor assembly workshop. Source: ZL Vortice Project, 2019. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

3 The Floodplain Engineering

ZL Vortice's strategy of interlocution with the government's programs for the area did not have significant outcomes. The CDHU activities in União de Vila Nova were terminated and there was no support for new initiatives. The intensification of urban and environmental degradation in the area and the predominance of large flood-containment structures projects in the formulation of public policies led to the imposition of a polder system – the Tietê River Floodplains Park (PVRT), not yet completed, designed by the Department of Water and Electric Energy (DAEE) – for the entire floodplain of the Tietê River in São Paulo. The flooding problem is addressed through major engineering works of polderization (containment system composed of concrete dikes, reservoir and hydraulic device), resulting in the radical segregation between the river and the city.

At Jardim Pantanal, the DAEE proposes to build a concrete wall and hydraulic equipment for flood control, along the banks of the Tietê River and the São Martinho creek. The device will irreversibly compromise the floodplain urbanization, already affected by the landfills, completely disrupting the hydrographic basin's hydrology. The polder construction would imply: the transformation of the stream into an adductor channel; the isolation of the remaining wetland along the Tietê River (Pesqueiro), which could serve to treat part of the water used in urban occupation; the conversion of settlement areas into hydraulic system reservoirs, with the removal of residents and suppression of the community area of Cotovelo.

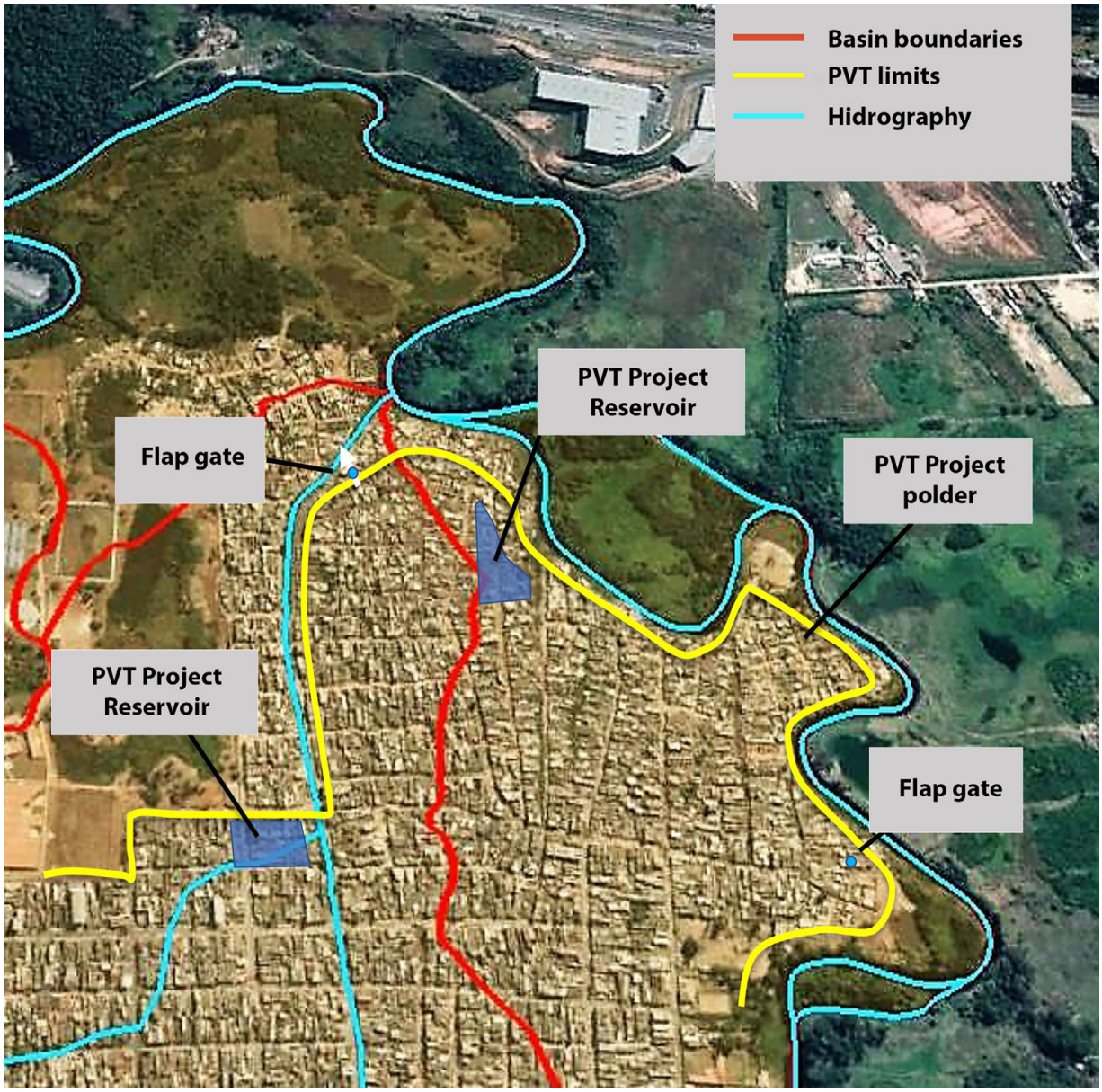

Fig. 9: PVRT polder project in Jardim Pantanal, São Martinho's creek basin. Source: ZL Vortice, 2019, cf. DAEE / Engecorps Typsa Consortium.

Today, the predominance of civil engineering in urban infrastructure works, established in the crises caused by large floods, has been critically reexamined. Controlling floods entails the exclusion of natural systems by instituting a rigid division between dry and flooded land, between high and low terrain. A critical analysis of these engineering efficiency and control principles catalyzes ecological strategies, enabling the development of more contingent and flexible designs. The integration of infrastructure with natural processes sets new paradigms: water treatment and sewage systems can no longer be designed without considering their watersheds. River basins are now understood as an ecological infrastructure (Bélanger, 2017).

The procedures adopted in União de Vila Nova, where the river-city relationship and community participation are preserved, are not repeated in upstream areas. CDHU's urbanization projects on the Tietê River floodplain are subject to restrictions. Thus, the dialogue between ZL Vortice in the meander belt area, under the jurisdiction of DAEE, was very limited. On the other hand, the experience provided a broad learning process in the elaboration of public policies and highlighted ways of structuring the floodplain by large engineering works.

4 Research Laboratories: technologies for critical situations

This process allows ZL Vortice to establish the parameters of the project for the Jardim Pantanal area: to articulate research laboratories focused on the development of drainage and water management technologies, with the participation of residents, for the critical conditions of the Tiete floodplain. The proposal is to emphasize multidisciplinary cartography, sensing and modeling practices, capable of instrumentalizing the watershed, and enabling researchers and communities to seek environmentally sustainable technical solutions. The establishment of the Cotovelo experimentation site, a field laboratory in an area provided by the

community where the proposed technologies will be improved and tested with residents, is an important differential of ZL Vortice.

Fig. 10: Cotovelo experimentation site, "Nekinha's Space". Source: ZL Vortice Project, 2019. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

In the different stages carried out from 2017 to 2019, and described in an article previously published in V!RUS magazine (Peixoto, 2020), the following projects were developed:

- Permeable sidewalks, designed by artist Regina Silveira together with residents, in collaboration with the LME Poli-USP (Microstructure and Eco-efficiency Laboratory of the University of São Paulo Polytechnic School), directed by Rafael Pileggi. Interlocking floor in concrete, permeable and colored, formulated to allow the manufacture, implementation, and maintenance by the community. The pavement allows the infiltration of rainwater, helping to mitigate floods, and is also a public space.

– Draining galleries, developed by FabLab FAU-USP (Digital Fabrication Laboratory of the University of São Paulo School of Architecture and Urbanism), directed by Paulo Fonseca. Rainwater drainage system composed of molds shaped and executed by digital fabrication and produced in high-performance microconcrete. Drainage device, manufactured and installed by residents, which prevents puddles caused by indiscriminate landfilling of the floodplain.

– Constructed wetlands, a project organized by Luiz Orsini Yazaki, former coordinator of the Technological Center for Hydraulics Foundation (FCTH). Apparatus for filtering water from the river and streams, built and operated with the participation of the community, which is integrated into the local hydrological system, reinforcing the environmental service naturally provided by the floodplain. Experiment with new sustainable and low-cost water treatment technologies.

– Containment of stream banks, developed with the initial guidance of Claudio Silva (Brazilian Association of Portland Cement – ABCP). Experimentation of methods for stabilizing river slopes, with articulated concrete blocks, manufactured on site by residents. Flexible, terrain-adaptable, and vegetable systems to support stream banks. They serve to reduce erosion, helping to consolidate the river plain and the remaining hydrological dynamics.

– Monitoring of the river, water quality, and debris deposition, developed by LabTEC PUC/SP (Laboratory of the Digital Design and Intelligence Technologies Program of Pontifical Catholic University of São Paulo). Sensor systems that allow to assess environmental conditions in the watershed and the proposed technologies' performance. The monitoring equipment, consisting of a water quality meter, a rainfall meter (rain gauge), a flow and water level meter (fluviometer), and a permeability sensor (tensiometer), will be installed and operated by the residents.

ZL Vortice's proposals for integrated systems of water management and urbanization are related to projects developed in several Latin American cities. For example, in Santiago, Chile, the La Hondonada Park (hydraulic

infrastructure in an old quarry that handles turbid water, functioning as a public space) and the Paseo Cívico Metropolitano (public space restoration with water infrastructure based on sustainable urban drainage). In Medellin, Colombia, the Medellin River Parks (green areas along the river, forming a metropolitan biotic corridor integrated into the watershed). In Mexico City, the Volta a Cidade Lake project (recovery of Lake Texcoco with a lacustrine system fed by wastewater), the La Quebradora water park (reconfiguration of the hydraulic system by conducting the runoff to an infiltration basin), and the recovery of the *chinampas* system (channel networks and islets in shallow lakes and detention basins, used for family farming) (Mostafi et al., 2019).

5 The Field Laboratory

In an attempt to execute the operations proposed by ZL Vortice, researchers were faced with the following problem: how to take the technologies conceived in their laboratories to the floodplain? In 2017 and 2018, we conducted field expeditions to investigate the conditions for the development of proposals. We took visits to the areas planned for polder installation, to streets where draining galleries could be installed and to the swamp designated to the construction of a wetland for water treatment. The researchers' visits served to promote a dialogue with the local community, organized by AMOJAP. In conducting the expeditions, researchers and residents identified the different situations on maps, incorporating the location's technical language, essential for the appropriation of the place.

Fig. 11: Visits to the Jardim Pantanal area, accompanied by residents (2017-2018). Source: ZL Vortice Project, 2019. Available at: https://zlvortice.wordpress.com/. Accessed: 19 Jnuary 2021.

As a protocol, laboratories deal only with purified artifacts, based on rules and standards (quality, safety), indifferent to localities and tacit knowledge, eliminating non-standardized items. According to this principle,

questions can only have objective answers in the laboratory, which separates the investigation from social concerns and practices where that knowledge was inserted. The situation is totally different when dealing with complex processes under critical conditions. Here, researchers need to review their processes against a body of knowledge that cannot be disqualified *a priori*. They have to articulate their projects with other agents in the area.

What changes on leaving the laboratory? The researcher is no longer addressing just his colleagues, he participates in the invention of essentially technical and social improvements. Everything changes when one leaves the laboratory: they find the soil unevenness, the materials density, the climatic instability. There is a world in which other actors operate (Stengers, 2013). Upon leaving the laboratory, the researcher is faced with the resident, who, in addition to practical experience, now is able to locate himself on maps and work with the materials and systems introduced by laboratories.

6 Developing technologies

Researchers used the parameters established for the floodplain and the intense interaction with the community to define their proposals. In 2017, the residents made several visits to the laboratory facilities, promoted by AMOJAP, to learn about equipment and experimental procedures.

Fig. 12: Workshop with Jardim Pantanal residents at FAU-USP FabLab (2017). Source: ZL Vortice Project, 2017. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

Fig. 13: Workshop with Jardim Pantanal residents at LME Poli-USP (2017). Source: ZL Vortice Project, 2017. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

Once the technologies are designed, it is necessary to move once more the research from the laboratories' facilities back to the floodplain, with the production of prototypes and the community technical training. Tests under floodplain conditions must assess the prototypes' performance and document the adopted procedures, displaying to public agents and residents the chosen techniques and showing that the solutions proposed by laboratories have practical application. In 2018, laboratories held workshops at the Jardim Pantanal experimentation site to design and test the modeling and molding of different construction elements. The question posed was: Would researchers be able to repeat, in the floodplain, the production processes configured under laboratory conditions in university facilities?

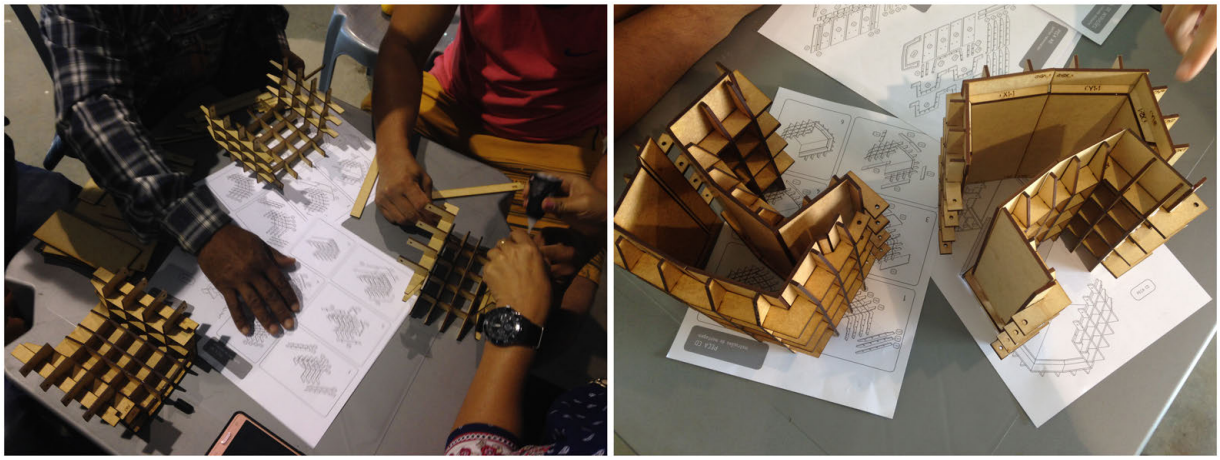

Fig. 14: FabLab workshop at FAU-USP at Cotovelo experimentation site (2018). Source: ZL Vortice Project, 2018. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

Fig. 15: LME Poli-USP workshop at the Cotovelo experimentation site (2018). Source: ZL Vortice Project, 2018. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

Fig. 16: LabTEC – PUC/SP Workshops in Jardim Pantanal (2015). Source: ZL Vortice Project, 2016. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

To ensure that the procedures and tests are consistent enough to constitute field trials, it is necessary to extend the laboratory and to transform a sufficient number of floodplain conditions into quasi-laboratory conditions. It will be impossible to demonstrate technological solutions' effectiveness if the floodplain is not, to some extent, transformed into an annex to the laboratory (Latour, 1984).

But how to expand laboratory practice? Extending the laboratory itself to the floodplain, converting the field into a laboratory. The solutions can only work if the floodplain stretch chosen for the field tests is transformed, with the participation of residents, social organizations, and public agents, in accordance with the research laboratories' prescriptions. Laboratory procedures can be extended to the entire floodplain, on the condition a set of laboratory practices, such as measurements, records, and constant monitoring, are respected.

7 Instrumenting the Hydrographic Basin

How does this knowledge return from laboratories to the floodplain? A socially shared arsenal of techniques (manuals, instruments, and systematization of parameters and procedures) supports the field laboratory operation. A large support network is needed to sustain the proposed technological solutions. A technical device is only maintained if a set of measures warrants its consistency, ensured by the repetition of laboratory practices by local authorities and communities (Latour, 2017). The way to prepare the ground for laboratories involves the equipping of the watershed with a sufficient number of instruments. The extension of laboratory conditions turns the floodplain into a large laboratory. The proposed procedures also involve the monitoring, geophysical investigation, and hydrologic simulation. These operations allow us to visualize and analyze the intervention areas through sensors and models. It is through the systematic instrumentation of the place that people will learn how to inhabit it in new ways.

Installing laboratories in critical situations serves to redefine the meaning of a place occupation. Claiming a territory for research, intervention, and housing reveals how much we do not know about it. How many partners were included in the design and appropriation of the place? How does the water drain into it? What is the soil's porosity? What is the declivity of the area resulting from the landfill? How will the proposed actions be monitored and maintained? The hydrographic basin accumulates data-collection and processing instruments, so that its dynamics are apprehended by researchers, public agents, and residents. The territory is subject to continuous monitoring. The actors, responsible for the anthropic effects on the environment, become aware of their actions through the multiplication of devices. Instruments and models allow the evolution of local environmental conditions to be described for all to see and react to it. That demands more hydrology, more geomorphology, more urbanism, more sensing (Latour, Weibel, 2020).

8 How to Make the Project Viable?

After establishing the procedures and technologies for the development of water management and treatment and re-urbanization, it was necessary to resume the dialogue with public managers and find ways to guarantee the conditions to carry out the works. ZL Vortice then presented a proposal to the State Water Resources Fund (FEHIDRO), managed by the Upper Tietê Basin Committee (CBH-AT)[1]. The elaboration of the proposal for FEHIDRO demanded a great effort of articulation of the different laboratories, the elaboration of a single integrated project. The proposed effort encompassed all the technologies that constitute the ZL Vortice project, including drainage galleries, constructed wetlands, stream containment, permeable sidewalks, and sensor systems, in addition to geomorphological and hydrological surveys. The proposal, however, was considered unqualified (CBH-AT, 2019), according to the following assessment:

> The project does not demonstrate integration with the existing project for the area, the Floodplain Park (PVRT). The project foresees the implementation of a wetland in the floodplain, which will operate under water during flooding periods, as it is located in the floodplain, including areas below the Tietê River flood level. The application of the constructed wetlands' model as the final outlet of a micro-drainage gallery system is not applicable in that region, since it is a low area, thus subject to water return. The proposed project conflicts with the DAEE polderization project, as it envisages the implementation of a regular drainage network, consisting of galleries, flowing into a constructed wetland, without a prediction of what would be the water return treatment during floods. The project does not demonstrate how permeable floors could work for the infiltration of rainwater in floodplain areas (ZL Vórtice, 2019, our translation).

ZL Vortice presented an appeal, arguing that the project intends to test the efficiency of environmentally sustainable interventions, with the points listed by the evaluation being known and also part of the investigation of constructed wetland, drainage galleries, and permeable pavement. Generally, wetlands are built in floodplains and therefore it is normal for them to flood during a few days in rainy seasons. In order to allow the total flooding of the wetland, flow equalization tubes are foreseen, so that the river waters, when they are rising, enter the wetland and equalize with the remaining flow.

The draining galleries, on the other hand, are designed considering the terrain slope, obtained from digital modeling made with LIDAR, the flow contribution area served by the gallery, calculated through georeferencing, and the region's rainfall indexes, obtained by sensors to be installed by the project. Those data will allow the calculation of the required drainage, guiding the galleries' dimension and the expected slope. The permeable sidewalks, finally, must be installed considering the soil permeability, obtained through tests to be carried out with tensiometers, the flow volume of the gallery system that intersects the sidewalk and the flow capacity of the streams to which will be directed the flows resulting from the galleries and permeable sidewalks.

Although ZL Vortice has made a great effort to interact with the projects and the public policies promoted by the agencies operating in the Tietê River floodplain through seminars and technical visits, and to incorporate surveys and guidelines of the main river basin plans, especially the APA VRT Management Plan, the public administration instances that manage the proposed actions for the area reject experimental projects aimed at technological innovation. The participation of research laboratories in the formulation of public policies for the Upper Tietê Hydrographic Basin is not evident.

9 Strategy: redirecting to the urban area

What was the result of this dialogue with the public administration? To what extent did it contribute to the project's development? The experience allowed us to better understand the mechanism of formulation of public policies for the hydrographic basin and to consolidate approaches to water management, environmental preservation, and urban planning that seek sustainable, community-oriented solutions. The APA VRT Management Plan established the general parameters for analyzing the area. The critical conditions of the Tietê River floodplain in the city of São Paulo require an integrated water management and urbanization project, with technological innovation and social participation. Faced with the obstruction to proposals that encompass the meandric remnants of the Tietê River, ZL Vortice's initiatives will focus on the occupied floodplain. It is necessary to direct efforts to the only floodplain area in the eastern zone of the city that has not yet been structured by major engineering works: Jardim Pantanal. There, outside the polder's projected perimeter, the institutional relationship is made with other public agents: APA VRT and the City Hall.

There is a shift in the investigative axis of ZL Vortice: the preservation of the meander belt remnants, which was the objective of the initial geomorphological and hydrological surveys, and the proposed water treatment by constructed wetlands, is impaired by the polder project. The research is redirected to the hydrographic basins of its tributaries, particularly the São Martinho creek. The focus is now on urban hydrology: landfill, drainage, creek-city relationship. In the occupied area, environmental degradation has reached its limit: the investigation is now dealing directly with the impacts caused by disorderly urbanization and large flood-countenance works. The meander belt, the integration of the city with the river, remains as a reference to ensure the environmentally sustainable character of the proposed urbanization projects.

The first initiative resulting from this redirection was the conduction, in 2019, of a detailed survey of the water courses, existing infrastructure, and urban occupation. Field expeditions, conducted by Alexandre Gonçalves, from Estudio Laborg, tried to determine the occupied floodplain's basic features. Those surveys allowed us to identify the streets that, due to constant pooling, show irregular terrain and ponds landfilling that are, therefore, more suitable for the implementation of draining galleries and permeable sidewalks. Land slope maps were drawn up on each street, an essential measure for elaborating drainage system projects. The procedure made it possible to incorporate specific phenomena that affect the territory into the area cartography. ZL Vortice maps have become more complex and accurate.

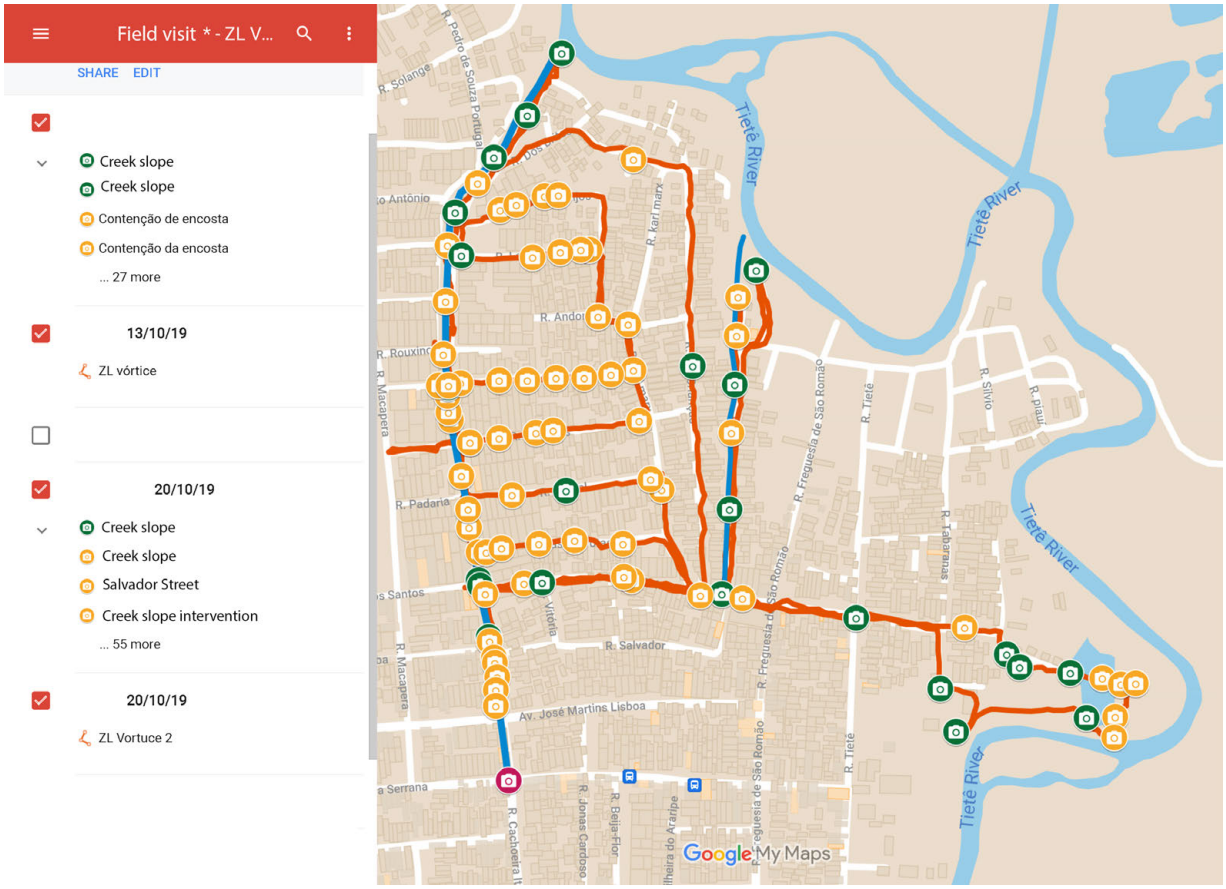

Fig. 17: Interactive map of area reconnaissance and registering expeditions (2019). Source: Projeto ZL Vortice, 2019. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

10 Visualization

The ZL Vortice project was presented in 2020, by invitation of Harvard University's Graduate School of Design, in the *Ecological Urbanism* exhibition, at the Museu da Casa Brasileira, in São Paulo[2]. For the exhibition, indicative maps of the main environmental and urban processes that affect the area were elaborated, resuming the surveys carried out by APA VRT Management Plan and by ZL Vortice field expeditions. The exhibition also promoted meetings with researchers and residents, who detailed issues related to hydrology, design, and production of urban infrastructure[3].

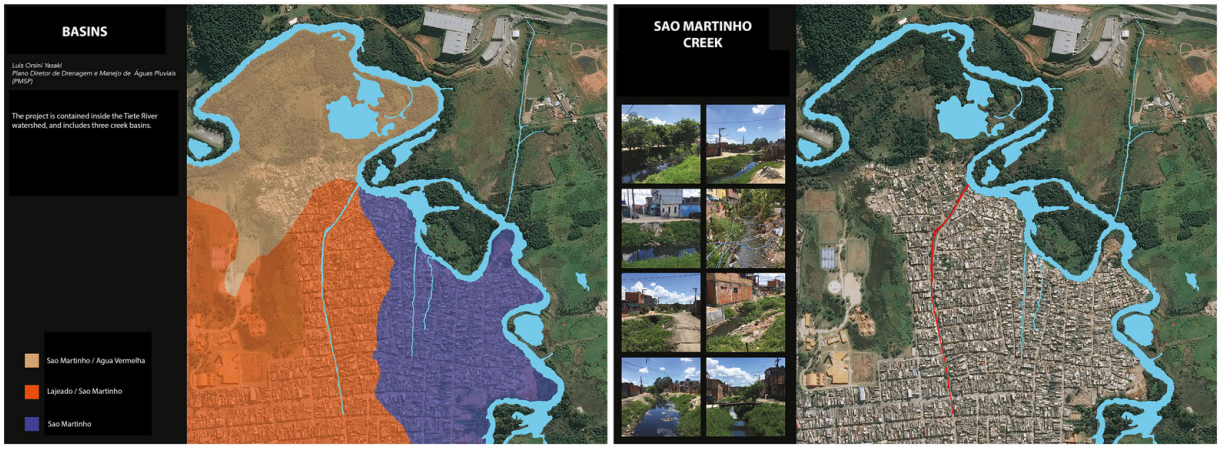

Fig. 18: Panels and maps from the *Ecological Urbanism* exhibition. Source: ZL Vortice Project, 2020. Available at: https://zlvortice.wordpress.com/. Accessed: 25 February 2021.

The investigation and exhibition process resulted in the elaboration of models, an important instrument of interaction with residents and public agents. Presenting the updated street layout of the region, the landfill area and the streams, a first model allowed the population to contribute to the terrain recognition, indicating critical areas and locations more prone to interventions. Another model, with an interactive mapped projection of cartography and photographs, reveals the dynamics that affect the territory. The models add a new visualization layer to the Pantanal territory.

Fig. 19: Models produced by laser cutting and with interactive mapped projection. Source: ZL Vortice Project, 2020. Available at: https://zlvortice.wordpress.com/. Accessed: 19 January 2021.

On April 27, 2021, TV Cultura broadcasted a program, recorded in Jardim Pantanal, about the permeable sidewalks project proposed by ZL Vortice, with artist Regina Silveira, Rafael Pileggi from LME-PoliUSP, and residents[4].

Fig. 20: Recording of the program "Habitar a Cidade" [Living in the City], in Jardim Pantanal. Source: ZL Vortice Project, 2021. Available at: https://zlvortice.wordpress.com/. Accessed: 27 April 2021.

11 Parameterizing the Terrain

The survey carried out by Estudio Laborg continued with the use of the LIDAR (Light Detection And Ranging) tool, an optical remote sensing technology applied to topographic surveys and terrain modeling[5]. The tool allowed for a detailed altimetric mapping, with precision in the order of 10 cm (3.93 inches) and average density of 10 points/m2 (/107.6 sq feet). With this, a precise topographic model of the terrain resulting from the embankment and the configuration of streets (dimensions, slope variations) and streams (dimensions and slopes) was obtained. This detailed calculation, with much more accurate indexes than it would be possible to obtain with the available contour lines, made it possible to dimension and plan the implantation of draining galleries, stream margin contention, and permeable sidewalks, with basic technical measurements. Fundamental criteria for the location of ZL Vortice projects are: working with water, instead of against it, as in polder engineering (Sennett, 2008). Follow the flow, monitor the terrain, integrating the proposed technologies into the drainage system of the hydrographic basin.

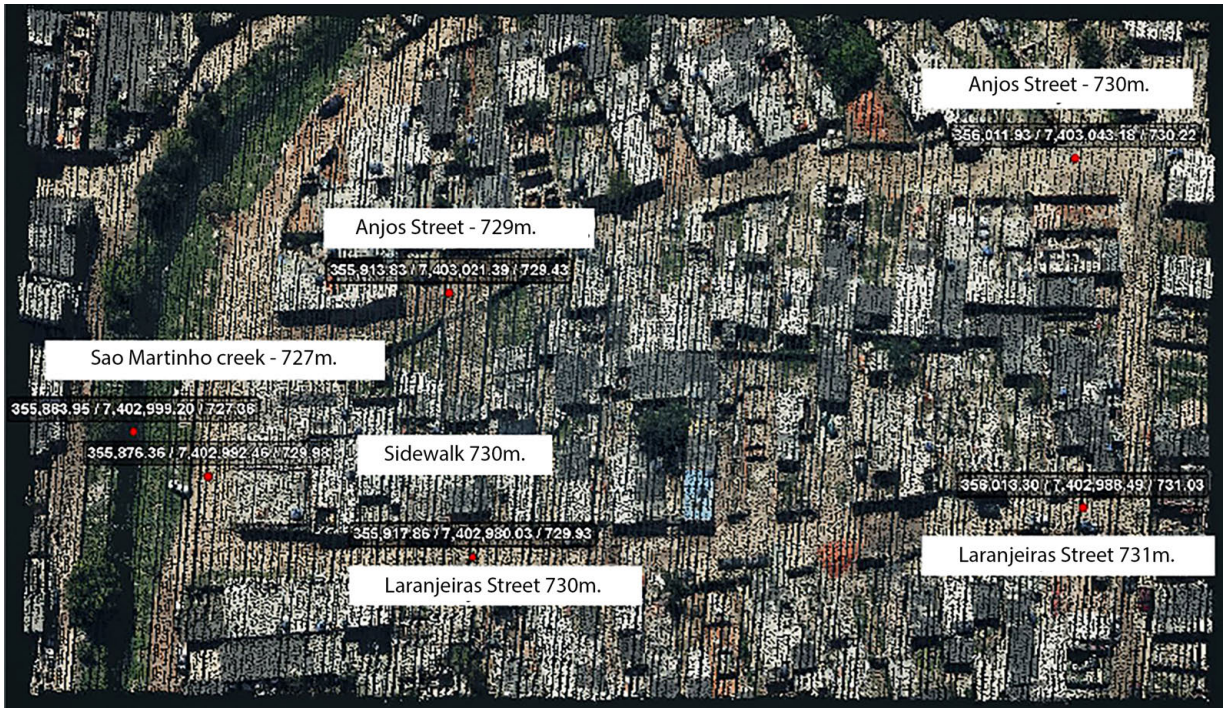

Fig. 21: Altimetry of the streets that flow into the São Martinho creek. LIDAR — Estudio Laborg. Source: ZL Vortice Project, 2020. Available at: https://zlvortice.wordpress.com/. Accessed: 25 February 2021.

The instrumentation allowed the extension, albeit precariously, of the metrological network throughout the hydrographic basin. Researchers (and also residents) now have accurate maps, models, terrain models produced by remote sensing, hydrology simulation made with flow calculations and drainage projects, allowing the transition from visual observation to data inspection. The laboratory extends across the floodplain.

12 Intervention Proposal

The next step will be to build, with the laboratories' resources and the community commitment, one of the proposed projects: the permeable sidewalk, on the Cachoeira de Itaguassava Street, along the São Martinho creek. The basic parameters for the sidewalk location were established using the topography maps resulting from the surveys carried out by ZL Vortice.

Fig. 22: Dimensions of the areas available for the proposed sidewalk to Cachoeira de Itaguassava Street. Source: Authors, 2021.

For the execution of the permeable sidewalk takes into account the floodplain's urban and environmental situation, it must be designed according to the expected stream flow and surface runoff from the impacted area. Under the guidance of engineer Luiz Orsini Yazaki, the modeling of the hydrographic basin flow and the

urban area drainage in the work implementation area is being prepared, in order to measure the volume of runoff to which the sidewalk will be submitted. The calculation of the amount of water the streets pour into the system will allow the assessment of the required water capacity of the drains to meet that volume. Those data will enable LME Poli-USP, responsible for manufacturing the pavement, to dimension the settlement base, gutter, manholes, and ducts.

Fig. 23: Schematic map of the surface runoff in transversal streets converging on the sidewalk and urban design of the area, with contention of the stream margin, gutter, manholes and drain. Source: Authors, 2021.

Although this is the implementation of just one of the technologies developed by ZL Vortice, the process of constructing the permeable sidewalk makes all programmed procedures converge. The pavement is conceived as part of an integrated system, which articulates different water management and urbanization technologies. It is necessary to dimension the pavement according to the terrain, the drainage conditions and the integration with other projects proposed for the area. The sidewalk project must assume the implementation of a drainage gallery designed for the perpendicular street and the containment device with concrete blocks in the stretch of São Martinho creek, where the permeable pavement will be installed. It also demands projecting the intersection between different technologies, provided with distinct constructive systems.

LME-Poli USP has established protocols for tile fabrication, including cementitious mix, pigmentation processes and molding procedures. It was also up to the laboratory to determine the process of the sidewalk production and the organization of the manufacturing process, at the Cotovelo experimentation site, by residents. Production must be done by sequential actions: several large benches gather different teams, who prepare the mixture, pour the concrete into the molds, add the pigment and place the molds on shelves for drying, then take them to the implantation site, and settle the pavements. The experimentation site is a manufacturing facility, consisting of a series of operations, division of labor and the producer's technical skill using simple tools (Ferro, 2006). The technical understanding of the activities eventually allows changes in the project during its execution, adaptable according to modifications proposed by the residents.

The experimentation site is the field laboratory, a space for experience in work management and knowledge production. The project complexity is an opportunity to see how residents will contribute to improve the production and implantation process (construction of the base, laying of floors, and drainage pipes) on the sidewalk. In the interaction with the laboratory, the technology transfer and conversion of new procedures into community skills will be taken into account.

13 Conclusions

These are the operations carried out by ZL Vortice aiming at the instrumentalization of the Tietê River floodplain, in Jardim Pantanal. The project's horizon are the hydrographic basins conditions in the outskirts of Latin American metropolises, affected by major infrastructure works and disorderly urban occupation. ZL Vortice shares with several projects in Latin America the search for socially and ecologically sustainable solutions for the preservation of water resources, water treatment, and urban restoration. It is indicative of the intense regional research for inclusive and low-cost technologies, specific to local conditions, that benefit from the insertion in community networks to seek new ways of reversing environmental liabilities and urban inequalities.

The execution of works in an environmental protection area, even on an experimental basis, requires the authorization of regulatory entities, which implies dealing with the exceptional legal and political conditions of the floodplain. The entities responsible for the grant are the Management Council of APA Rio Tietê Floodplain and the City of São Paulo. The authorization request to the APA management for the permeable pavement construction is in progress[6]. With the eventual authorization for its implantation, the hydrographic basin instrumentation work, the Jardim Pantanal territory appropriation by researchers and residents will then be able to move forward.

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1 MediaLab/ZL Vortice, integrated water management and treatment system for urban and environmental rehabilitation in the Tietê River meander plain, eastern stretch of the city of São Paulo-SP. FEHIDRO Venture, March 2019.

2 Images of the exhibition are available on the Museu da Casa Brasileira website, at https://mcb.org.br/pt/programacao/exposicoes/mostra-urbanismo-ecologico-2020/. Accessed on: Feb. 25, 2021.

3 Video recordings of the meetings are available on the Museu da Casa Brasileira website. Available at: https://youtu.be/Z_8ivAg6pos and https://youtu.be/NceAtY2MWcw. Accessed on: Apr. 10, 2021.

4 Program of the series "Café Filosófico," entitled ”Living in the City”. Available at: https://youtu.be/54-jTIb1XT4. Accessed on: Apr. 27, 2021.

5 Altimetric mapping for project implementation. Source: ZL Vortice, 2021. Available at: https://zlvortice.wordpress.com/. Accessed on: May 25, 2021.

6 Implantation on an experimental, precarious basis of permeable pavement in Jardim Pantanal – submitted to the Management Board of APA Tietê River Floodplain on 01/26/2021.