

# Small-scale green infrastructure importance in urban drainage: a case study of the República Argentina Avenue, Curitiba-Brazil.

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**Abstract.** This article aims to describe and analyse green infrastructure strategies applied at the urban design level, particularly the small-scale, with the purpose of landscape and urban drainage. It specifically addresses proposals for interventions on the República Argentina Avenue, in Curitiba – Brazil. Literature review and the creating of a cartographic base for data analysis was made as part of the methodology process. The design strategies proposed the readjustment of space through the implementation of small-scale green infrastructure components. The intention was that towards the reconfigurations of the spaces a more resilient path could be made, making the place more pleasant for users due to the presence of vegetation and more sustainable.

**Keywords.** Small-scale, green infrastructure, sustainability, revitalization.

## 1. Introduction

In the last decades, urban planners have striving to find solutions that try to balance urban and environmental functions. Floods, landslides, heat islands are results of an unbalanced relation of those functions. Regarding towards the result of an unbalanced environment caused by the urbanization process, various urban planning theories started to appear in the 60s's guided by an ecosystemic view [1].

With the purpose of harmonize human occupation with the conservation of natural resources and processes, those theories became urbanistic tendency in the XXI century and the main way to development more sustainable cities [1].

The green infrastructure is one tool of low environmental impact urbanism that should be highlighted. According to Ferreira e Machado [2], when strategies to implement a natural elements network are put in place, connected with the landscape itself, to optimize and expand the environmental services that a city need, we have an urban green infrastructure. The green infrastructure is a set of landscapes that are implemented to guarantee a more lasting urbanization [3].

According to Yu e Padua [4], there are three green infrastructure scales: macro, intermediary and small. The macro scale has regional coverage and it can function as flood control element and green corridors for wildlife; the intermediary scale integrates the macro and small scale, and for that reason it can have many functions such as mobility

and recreation; and the small scale is used to define the physical structure of the urban development, such as rain gardens, bioswales, permeable pavements.

The city of Curitiba, located in the state of Paraná, Brazil, has according to Froes [5] the fame of being a “humanist” city, successful and efficient in the urban planning sphere, worldly known as Model City. Although the international recognition for its urban planning, Curitiba lacks in solutions in regards to small scale green infrastructure.

The intermediate scale stands out in the city, in the form of a network of parks that articulate the urban function of leisure and the environmental function of retention of rainwater. However, its roadway system known as “trinário”, that projected the city in the international scene of urban planning in the 70’s made by structural corridors with exclusive lane for the Bus Rapid Transit (BRT), was not redesigned to align with the new principals of sustainability that the green infrastructure offers and the modern cities need.

Nevertheless, the leading question described in this article was: which interventions are needed in public spaces within the structural corridors in order to improve the environmental quality of those spaces. In order to better grasp the concepts, a case study in the República Argentina Avenue was made. The Avenue has 5.8 km of extension, and it is located in the Southern Structural sector of the city.

The hypotheses were that with the transformation of the República Argentina Avenue in a green corridor using small scale green infrastructure for the purpose of urban drainage, an environmental improvement was the result.

## 2. Research Methods

For this article the following methods were used: 1) literature review; 2) data gathering of the intervention area and analysis of the data; 3) on-site visit.

### 2.1 Literature review

In order to have a better understanding in the state of the art, a literature review was made to best understand the concepts of urban drainage, green infrastructure and urban landscape. This review was made by books, articles and content found it on the web.

### 2.2 Data gathering and analysis

After the literature review, it was realized the data gathering and analysis of demographic and socioeconomic indicators for the intervention area as well as remote sensing imagens for the same area.

The analysis of the data described above was made by creating a cartographic base using shapefiles (.shp.) available by the Institute of Research and Urban Planning of Curitiba (IPPUC, in portuguese),

such as: street layout, lot, urban facilities, parks, squares, woods, gardens, neighborhood outlines, hydrography, level curves, zoning and bike lanes. The image containing the orthophoto (.tif) of the city was also available by the Institute of Research and Urban Planning of Curitiba [6].

The socioeconomic data used was issue in the 2010 Census, available by the Brazilian Institute of Geography and Statistics (IBGE, in portuguese), and it was the following: demographic density, number of households and average income by dissemination area [7].

Observations were also carried out directly on the site area, regarding land use and afforestation. The data were processed in the software QGIS, a free and opensource application to, among other functions, edit, analyze data and create maps for printing [8].

### 2.3 On-site visit

Last but not least, an on-site visit was made to observe interactions and spatial dynamics of the intervention by photographic register. Those observations were also made via Google Street View [9].

## 3. Results

From the spatial reading of the República Argentina Avenue (Fig. 1 and Fig. 2), several analyses of environmental, social-spatial and infrastructure aspects were developed within the scope of the diagnosis.

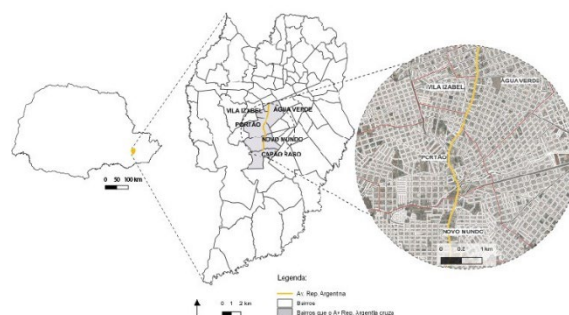
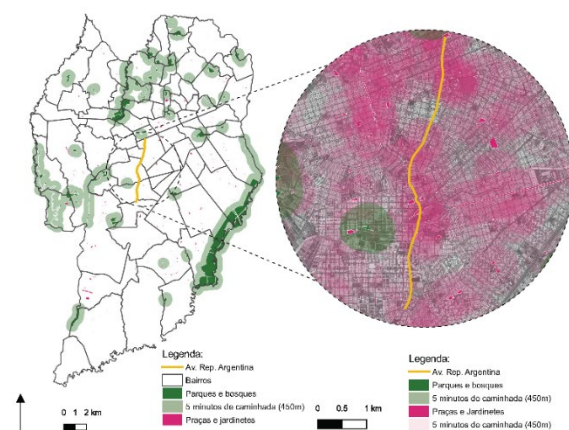


Fig. 1 – Localization map, of the State of Paraná, city of Curitiba and of the República Argentina Avenue. Elaborated by the authors.



**Fig. 2** – Green areas and squares in Curitiba (left), and green areas and squares in the surrounding areas of the República Argentina Avenue (right). Elaborated by the authors.

The result of these analysis showed a highly waterproofed soil, absence of green areas and vegetation, arid landscape due to the monochromatic aspect as well as noise pollution caused by the vehicles and buses.

From the results mentioned above, it was considered that the small-scale green infrastructure would be the most pertinent choice for the Structural sector under study. This choice is mostly likely to be efficient in consolidated urban spaces due to its easy implementation and low cost, compared to the intermediary and macro scale that achieved total urban landscape transformation.

Given the existing scenario and the considerations mentioned above, the authors proposed a revitalization project for the República Argentina Avenue, in which includes the implementation of rain bed and rain gardens, adding vegetation and increasing the permeable area (**Fig. 3**).



**Fig. 3** – Interventions proposed in the República Argentina Avenue. Elaborated by the authors.

In addition, the redesign of the sidewalks was also proposed, to provide a safer and more welcoming space for pedestrians (**Fig. 4**)



**Fig. 4** - Interventions proposed in the República Argentina Avenue. Elaborated by the authors.

## 4. Discussion

Small-scale green infrastructure proves to be an

effective tool to be used in urban design projects, as they help to mitigate the negative effects of high permeability of the soil in consolidate areas, such as the Southern Structural sector in Curitiba.

In this way, the central lane of the so “trinary” system, previously grey and impermeable, mostly occupied by asphalt and concrete, gives space to permeable pavements and rain gardens, improving the drainage and the heat island effect, resulting in a more pleasant and comfortable urban spaces for permanence and circulation (**Fig. 5**)



**Fig. 5** – Before and after of two points of the Interventions proposed in the República Argentina Avenue. Elaborated by the authors.

That is, the small-scale green infrastructure, here being proposed for the República Argentina Avenue, has also the potential to benefit commercial activities in the intervention area, which are located on the ground floor of existing buildings on the Southern Structural corridors, that are encouraged by land use and occupation legislation in the city of Curitiba.

The implementation of the small-scale green infrastructure would also have an impact on improving social well-being, as it would provide the population with greater contact with nature, through the simple action of circulating on the most tree-lined sidewalks and cycle lanes.

According to Amato-Lourenço et al. [10], the contact with nature is increasingly recognized as beneficial to humanity. It is common sense that physical exercise is also beneficial for people’s well-being and quality of life. In this regard, it should be noted that this space of the main lane of the República Argentina Avenue is currently used by residents for physical exercise such as walking, running and cycling.

## 5. Conclusion

The green infrastructure of small-scale, discussed in this article and the respective application proposals for the case study corroborate that this tool can be an ally of microscale urban drainage, promoting the infiltration of rainwater and the reduction of surface speed runoff. Actions that, if applied in the hydrographic basin as a whole, will relieve macro drainage systems.

In addition to the practical contribution to sanitation

engineering, small-scale green infrastructure proves to be a suitable design toll for creating pleasant urban landscapes, resembling some sort of green oasis, in the mist of the immensity of concrete cities, without necessarily depending on major interventions that would require substantial public resources and with a long work time frame.

In the case of Curitiba, the implementation of these small-scale actions in the set of the structural corridors, would result in green ways, absorbing rainwater, transforming carbon dioxide into oxygen, improving the quality of life of its residents and the thousands of public transportation users who travel the Southern Structural corridors daily.

Therefore, the revitalization of spaces using green infrastructure strategies, represents a possibility of creating more sustainable cities, by application of small-scale interventions that transform the environmental quality of large urban spaces.

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