

## Green Rooftops

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# BIODIVERCITIES

**BY 2030**



**TRANSFORMING CITIES  
WITH BIODIVERSITY**

MARÍA ANGÉLICA MEJÍA AND  
JUAN DAVID AMAYA-ESPINEL, EDITORS.





# BIODIVERCITIES



## BY 2030

**TRANSFORMING CITIES  
WITH BIODIVERSITY**

Editors: María Angélica Mejía  
and Juan David Amaya-Espinel.



BIODIVERCITIES BY 2030

TRANSFORMING CITIES WITH BIODIVERSITY

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# GREEN ROOFTOPS

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GIS data, rooftop  
agriculture, and green  
urban transformation

## COMMITMENTS

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**Rio de Janeiro is an ever-changing and expanding city that is facing challenges in terms of food security, urban sprawl, and the fragmentation of the green infrastructure. By mapping the surface area of the urban rooftop landscape and finding spatial synergies with the city's socially and environmentally vulnerable areas, a case can be made in favor of implementing a rooftop agricultural infrastructure capable of meeting roughly 40% of the city's yearly demands for vegetables.**

Rio de Janeiro is a 1200 km<sup>2</sup> city with 6,4 million inhabitants. It is a changing and growing urban system with a fragmented green infrastructure, a **food secu-**

**rity** crisis, and the constant threat of flooding. The current economic crisis and the unevenly distributed income increased the gap between the richest and the poorest classes in the last years. As a result of insufficient income, almost a third of the Brazilian population does not have adequate resources for acquiring the appropriate quantity and quality of food (Meade et al., 2004).

The city is a combination of dense urban areas in the northeast, tropical forests, gray streets and *favelas*, and extremely dense urban areas that grow organically on rocky hillsides.

After working in the city of Vienna in Austria, where flat roof surfaces were identified as underused spaces, the team of researchers started to explore Rio de

Janeiro's potential for rooftop agriculture. This meant: a) carrying out a **LIDAR-based mapping exercise** (which located all of the roofs with an inclination inferior to 5 degrees on 69% of the city's surface), b) analyzing key areas with high flat roof potential, c) evaluating the growing capacity of this flat roofs landscape, d) calculating the yearly demand of vegetables in the city, e) using data from the municipality and the Social Development Index (which combined educational level income, housing quality and level of basic sanitation) to determine which areas were socially vulnerable and, in turn, ripe for food insecurity, and f) visualizing specific locations with potential for rooftop agriculture. The project showed that 1,385 hectares of roofs would be suitable for rooftop agriculture and that this productive roof surface could meet

the yearly demand for vegetables of 39,2% of the population of Rio de Janeiro.

This initiative aimed to look at how rooftop agriculture could address food insecurity and the fragmentation of the green corridor networks. In simple terms, the research team created a model that connected geographic data with different parameters located within a given area. By looking at rooftops, seeing how big they were and how much food they could produce, you could ask questions such as: *Would it make sense to have a rooftop farm in X place where there is a lack of supermarkets? Would it be interesting to have a community-based garden in Y?* The idea was to test this model in Rio de Janeiro, where you have different challenges, ecosystems, and types of inhabitants.

RIO DE JANEIRO,  
BRAZIL

Pop. 6,748,000

1,200 km<sup>2</sup>

2.13 m.a.s.l.

KEY  
CONCEPTS

FOOD SECURITY

URBAN ACUPUNCTURE

ECOLOGICAL CONNECTIVITY

LIDAR-BASED MAP



After looking at all the flat roofs (and making some calculations), researchers found that the highly populated zones had the greatest potential, but they were also the areas with the highest social vulnerability. These are the typical community areas, such as *favelas*, where all this “block” kind of architecture can be seen, usually on two levels with a flat roof. People typically build them so that they can extend their structures later when they have more money (that is, when they build another level for a cousin, an uncle, etc.). What was interesting was that these sorts of buildings are constructed in a way that makes them strong enough to hold those rooftop gardens. Furthermore, if the rooftop is lower to the ground, then the green area on the rooftop has more impact on the microclimate on the street level<sup>1</sup>. So, it makes more sense to green those than the ones located in really high-rise buildings where they currently have little impact on the urban microclimate.

On rooftop gardens, you don't only grow food; you can also have flowers with substantial pollen and nectar for pollinators: the model took into account this aspect by looking at how far away those flat roofs are from each other. If they were within 500 meters from each other, it represents a suitable flight foraging distance for most common bee pollinators. Then the researchers considered that it would be like a green corridors network, which is connected enough so that pollinators could access it physically. In this sense, the study was also about raising awareness about the fact that ordinary urban spaces can be part of this flying path of pollinators. In a sense, it implies a complete change of perspective about the cityscape.

One project outcome was to create a digital map available on the municipality platform. The green roof potential map can be used as a tool to identify green roof locations in dense areas where little green space is available. Among other results, this research showed that 1,383 hectares of roofs would be suitable for intensive greening within the study area. This information was made available on the municipality platform<sup>2</sup> so property owners could have discussions and trigger community meetings and grass-roots initiatives to start a rooftop agriculture movement.

In the end, the project is about much more than technical results and scientific findings. It is about people coming together to reconnect with nature and learning to work and grow food collectively. It's about social innovation in the sense that you need to raise awareness among citizens and communities not only about sustainable agriculture, permaculture, agroforestry, food, nutrition, etc., but also about consumers becoming producers of their own food so that they're not just tied to where the supermarket is located (in the *favelas* there are few supermarkets, but plenty of small shops that never sell fresh, healthy food). By helping citizens become their own producers, they are being empowered.



## MULTIFUNCTIONAL ADDED GREEN STRUCTURE



Green rooftops layer



Building Layer



N

Source:

Maéva Dang, 2019.

THE RESULTS SHOW THAT IF

**THE CITY TRANSFORMS ONLY 53% OF ITS FLAT ROOF LANDSCAPE INTO ROOFTOP GARDENS,**

**IT WOULD PROVIDE ENOUGH VEGETABLES TO FEED ANNUALLY ALL THE INHABITANTS OF THE FAVELAS. IN ADDITION, IT WOULD STIMULATE BETTER FOOD EDUCATION AND PROVIDES FRESH VEGETABLES DIRECTLY IN AND BY THE HOUSEHOLDS.**

Finally, deep in its core, the study was not only about implementing a systemic approach using rooftop agriculture as a structure for urban transition but also about the concept of **urban acupuncture**, which is about finding relevant pinpoint strategies. In short, it was about pursuing localized selective interventions rather than extensive, expensive greening projects.

## KEY LESSONS



Multifunctional rooftop agriculture provides a large range of environmental benefits: the enhancement of the green corridors network **connectivity**, the improvement of the air quality, the production of local food, and the mitigation of the urban heat islands effect.



Rooftops are underused areas in cities<sup>3</sup>. Small-scale interventions such as rooftop gardens can be as environmentally and socially catalytic for urban environments as more expensive projects.



We should go beyond the dichotomy of rural and urban spaces. This misconception states that you grow your food only in the countryside or the city's outskirts, while the urban area is not made for it. In reality, those spaces could be used directly next to the consumer, so you don't have to transport processed food and package it, reducing pollution by bringing rural functions inside the city.



Making projects happen in *favelas* is challenging because people mistrust public authorities, and there's a lot of violence. You need to have a bottom-up approach as a recommendation to start such a project.

Green corridors network

Urban heat island

Food production potential

Roofscape for urban agriculture

**THE ENTIRE ROOFTOP SURFACE COULD PRODUCE AROUND 134'985 TONS OF VEGETABLES PER YEAR,**

**WHICH REPRESENTS 39.2% OF THE EVALUATED VEGETABLE REQUIREMENT OF RIO DE JANEIRO.**



The best way to trigger a bottom-up approach is to promote successful cases on buildings owned by the municipality to have the contagion effect. When something works well in communities like these, others replicate successful practices. This should always come from the citizens themselves and should never be imposed.