Green Rooftops

Dang, M.K.

Publication date
2022

Document Version
Final published version

Published in
Biodivercities by 2030 : transforming cities with biodiversity

Citation (APA)
Dang, M. K. (2022). Green Rooftops. In M. Angelica, & J. D. Amaya-Espinel (Eds.), *Biodivercities by 2030 : transforming cities with biodiversity* (pp. 158-161). Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. http://hdl.handle.net/20.500.11761/36048

BIODIVERCITIES

BY 2030

TRANSFORMING CITIES WITH BIODIVERSITY

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

INSTITUTO HUMBOLDT COLOMBIA

BIODIVERCITIES

BY 2030

TRANSFORMING CITIES WITH BIODIVERSITY

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

INSTITUTO HUMBOLDT COLOMBIA

BIODIVERCITIES BY 2030
TRANSFORMING CITIES WITH BIODIVERSITY

Edited by: María Angélica Mejía and Juan David Amaya-Espinel.

Editorial assistance:
Érika A. Peñuela.

Authors: Albert Kreisel, Alejandra Osejo, Alejandro Serrano, Ana María Garrido, Ana Vicente-Álvarez, Andrea Padilla, Andrés Ibáñez, Andrés Suárez-Castro, Angélica Hernández-Palma, Bibiana Gómez-Valencia, Brian Amaya, Brigitte Baptiste, Carlos Betancur, Carlos Correa, Carlos Cortés, Carlos Montoya, Carlos David Montoya, Carlos Mario Wagner-Wagner, Carmen Antuña, Carmen Bouyer, Carolina Rodríguez, Cassandra Johnson, Cielo Holguín, Claudia Álvarez, Cristina Camacho, Dairo Escobar, Daniel Raven-Ellison, David Montgomery, Diana Ruiz, Diana Wiesner, Duncan Mackay, Édgar Mora, Eduardo Haene, Edward Buitrago, Eliana Cardona, Eline van Remortel, Elizabeth Riaño, Emily Norford, Fernando Flórez, Frances Taylor, Germán Andrade, Germán Torres-Morales, Harini Nagendra, Ioana Biris, Irene García, Jaime Rovira, Jennifer Lenhart, Jhon Rodríguez, Juan Caicedo, Juan Guhl, Juan Múnera, Juan Sebastián Ulloa, Juana Figueroa, Juana Mariño, Julián Restrepo, Juliana Montoya, Laura Sokka, Leon Kapetas, Lucía Rojas, Luis Inostroza, Maéva Dang, Manuel Jaen, Marcela Noreña, María Camila Díaz, María Camila Méndez, María Cecilia Londoño, María del Pilar Arroyave, María Stella Sáchica, Marianne Katunaric, Mario A. Murcia-López, Masatoshi Funabashi, Mateo Hernández, Matías Ramírez, Maximilian Becker, Menno Schilthuizen, Natalia Trujillo, Nathalia M. V. Flórez-Zapata, Nicolás Galarza, Norbert Peeters, Óscar Mejía, Pablo Lazo, Paola Morales, Patrick Lydon, Piero Pelizzaro, Rigoberto Lugo, Sandra Castro, Sara Cabrera, Simon Bell, Tadashi Matsumoto, Theresa Williamson, Valentina Tovar and Yenifer Herrera-Varón.

Editorial Direction .Puntoaparte:
Andrés Barragán and Juan Mikán.
Proofreading: Nicole Bedoya, John Güechá, Andrés Hernández and Nicolás Sepúlveda.
Translated by: Lina Grisales.
Art Direction: Mateo L. Zúñiga, Andrés Álvarez and Felipe Caro.
Illustration: Guillermo Torres, Nere Guarrotxena, Sofía Londoño, Andrea Santana and Dylan Quintero.
Design: Andrés Álvarez, Felipe Caro, Inti Alonso and Laura Gutiérrez.

.Puntoaparte Editores

Photos and maps: Amazonian Institute of Scientific Research Sinchi, Carlos Montoya, Carlos Mario Wagner-Wagner, Catalytic Communities, Charlie Peel, Charlie Peel, Densurbam, EAFIT University, Eduardo Haene, Érika A. Peñuela, Fideicomiso Lagos de Torca, Germán Torres-Morales, Gimnasio Femenino, Illustrated guide to the birds of Santiago de Cali, Iván Potes, Jhon Rodríguez, Juan Hinacapié, Leonardo Centeno, Luis Inostroza, Maéva Dang, María Angélica Mejía, Ministry of Environment of Chile, Muncipality of Montería, Municipality of Curridabat, Olger Guzmán, OPUS. Design, architecture, landscape, Rizoma, Sebastián Saiter, Secretariat of Environment of Medellín, Senderos de Chile Foundation, Sergio Gómez, TALLER Architects, Taxon Expeditions, Urban Oasis Foundation (Fundación Oasis Urbano), VTT Technical Research Centre of Finland and Yumbo Futuro (TU).

Satellite images: Google Earth and IDECA Infraestructura de datos espaciales de Bogotá.

Geographic and demographic information: Amazonian Institute of Scientific Research Sinchi (Instituto Amazónico de Investigaciones Científicas–Sinchi), Official Website of the Republic of Argentina (Argentina.gob.ar), Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística), Chile National Congress Library (Biblioteca del Congreso Nacional de Chile - BCN), Los Llanos University (Universidad de Los Llanos), National Planning Department (Departamento Nacional de Planeación–DNP), Los Llanos Road Concession (Concesión Vial de Los Llanos S.A.S.), Greater London Authority Official Website, Medellín, how are we doing? (Medellín, ¿Cómo vamos?), Metropolitan Regional Government of Santiago (Gobierno Regional Metropolitano de Santiago), Municipality of Bogotá, Municipality of Medellín, Municipality of Montería, Municipality of Santa Cruz of Mompós, Municipality of Santiago of Cali, Municipality of Yumbo, National Administrative Department of Statistics (Departamento Administrativo Nacional de Estadística–DANE), National Statistics and Census Institute INEC - Costa Rica (Instituto Nacional de Estadística y Censos-INEC Costa Rica), NLS National Land Survey of Finland, Shenzhen Government Online, Statistics Finland and Statistics Netherlands (CBS).

BiodiverCities by 2030: Transforming Cities with Biodiversity was developed under Contract No. 21- 017, signed by the Administrative Department of the Presidency of the Republic of Colombia and the Alexander von Humboldt Biological Resources Research Institute. The latter carries out the conceptual and methodological development and global positioning of the BiodiverCities transformational initiative. BiodiverCities is part of the Public Sector Strategic Management Capacity Strengthening Program, through the line of urban development and Cities System for sustainability, productivity, and quality of life.

Alexander von Humboldt Biological Resources Research Institute

Hernando García, *General Director.*
Cristina Gómez García-Reyes, *Advisor to the Director (outgoing).*
Sandra Perdomo, *Head of Policy and International Affairs.*
María Angélica Mejía, *Lead of the BiodiverCities by 2030 Initiative.*
Gabriela Guerrero, *Manager of the National Commission on BiodiverCities by 2030.*
Érika A. Peñuela, *Project Assistant.*

First edition
July, 2022
Bogotá D.C.
Alexander von Humboldt Biological Resources Research Institute and Administrative Department of the Presidency of the Republic of Colombia (Dapre).

Suggested complete work citation:
Mejía, M. A., Amaya-Espinel, J. D. (eds.). BiodiverCities by 2030: Transforming Cities with Biodiversity. Bogotá. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, 2022.

CATALOGING DATA SHEET:
BiodiverCities by 2030: Transforming Cities with Biodiversity / edited by María Angélica Mejía and Juan David Amaya-Espinel. — Bogotá: Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, July 2022.

288 p.; 20 x 25 cm.

Includes bibliographical references, tables, figures, maps, and index.
ISBN printed work: 978-958-5183-48-3.
ISBN digital work: 978-958-5183-49-0.

1. Urban biodiversity, 2. Urban ecosystem services, 3. Urban ecology, 4. Urban Land use planning, 5. Colombia. I. Mejía, María Angélica and Juan David Amaya-Espinel (Eds.), II. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt

CDD: 354.35 Ed. 23.
Contribution number: 533.
Humboldt Catalog Record: 14972.

Cataloging in Publication (CIP) – Francisco Javier Matís Mahecha Library, Alexander von Humboldt Institute.

INSTITUTO HUMBOLDT COLOMBIA

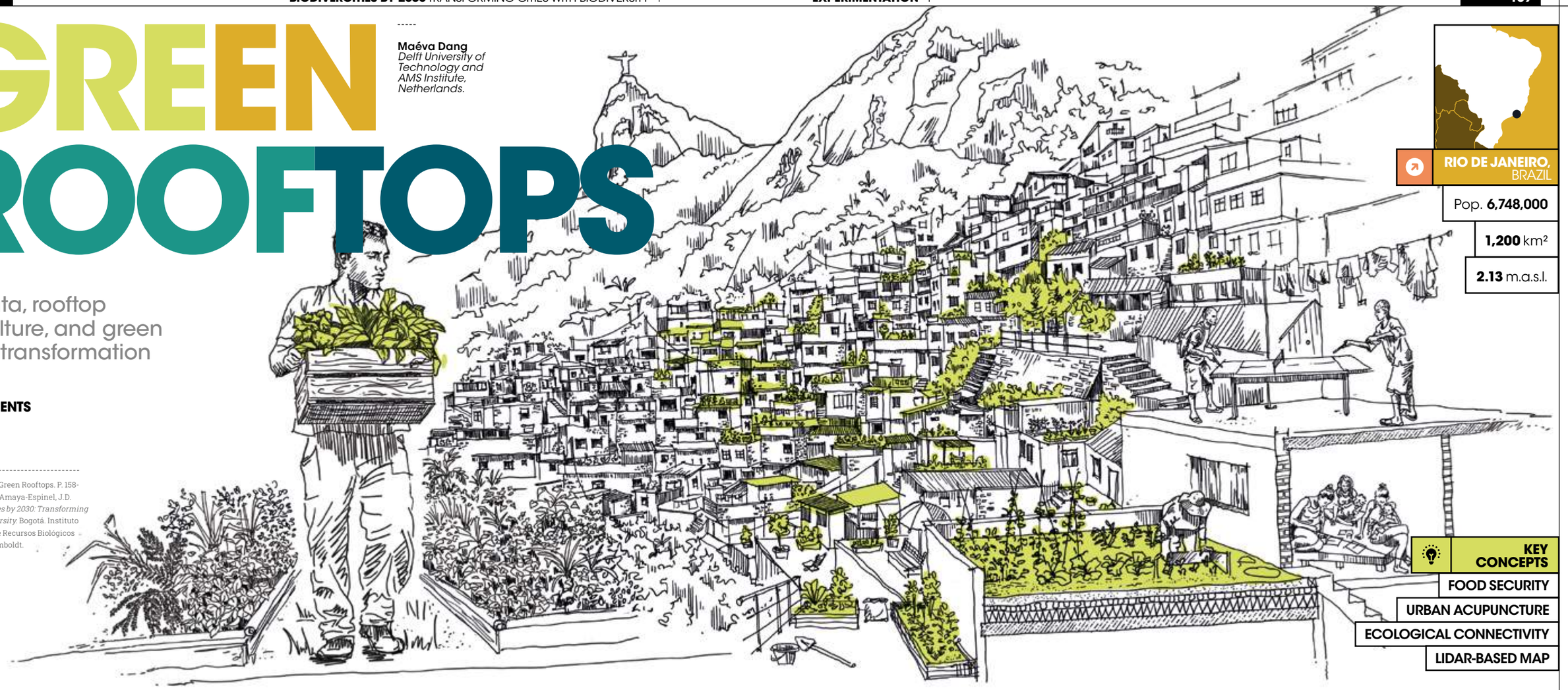
GREEN ROOFTOPS

Maéva Dang
Delft University of Technology and AMS Institute, Netherlands.

GIS data, rooftop agriculture, and green urban transformation

COMMITMENTS
2 4 5

Quote as: Dang, M. Green Rooftops. P. 158-161. In: Mejía, M.A., Amaya-Espinel, J.D. (eds.). *BiodiverCities by 2030: Transforming Cities with Biodiversity.* Bogotá. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. 2022. 288 pages.



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 km² city with 6,4 million inhabitants. It is a changing and growing urban system with a fragmented green infrastructure, a **food security** 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.

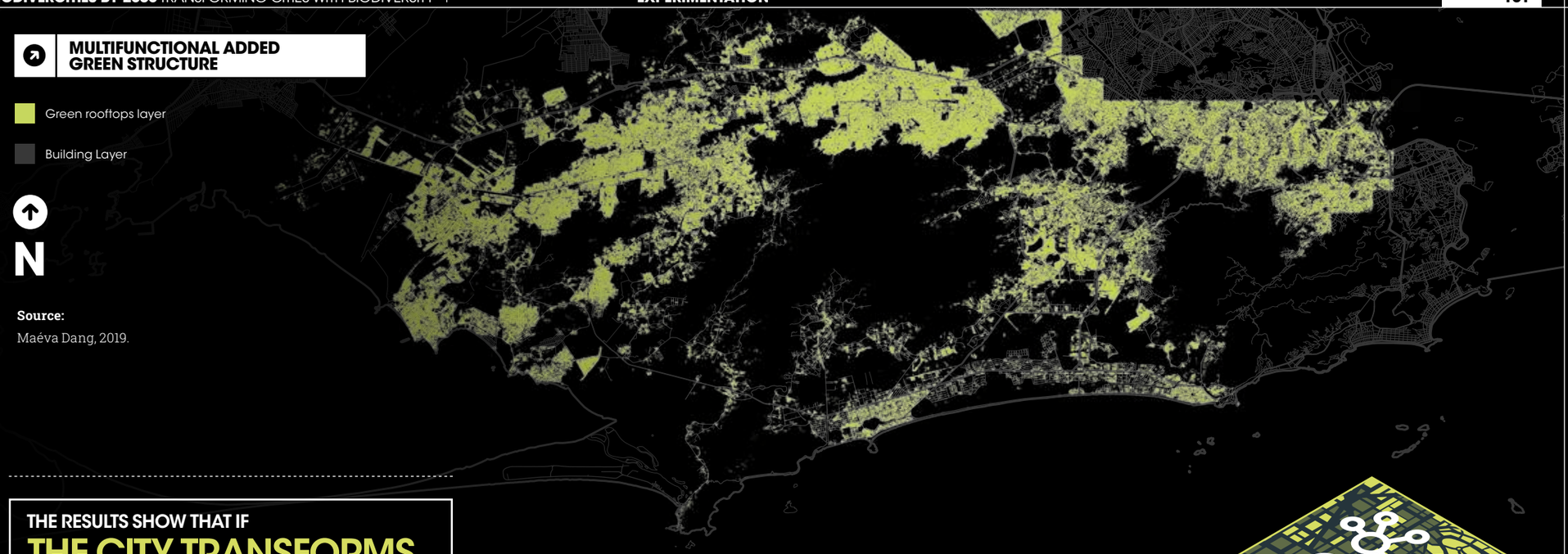
This initiative aimed to look at how rooftop agriculture could address food insecurity and the fragmentation of the green corridor networks. In simple terms, the research team created a model that connected geographic data with different parameters located within a given area. By looking at rooftops, 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.

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[1]. 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[2] so property owners could have discussions and trigger community meetings and grassroots 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.



Source:
Maéva Dang, 2019.

THE RESULTS SHOW THAT IF

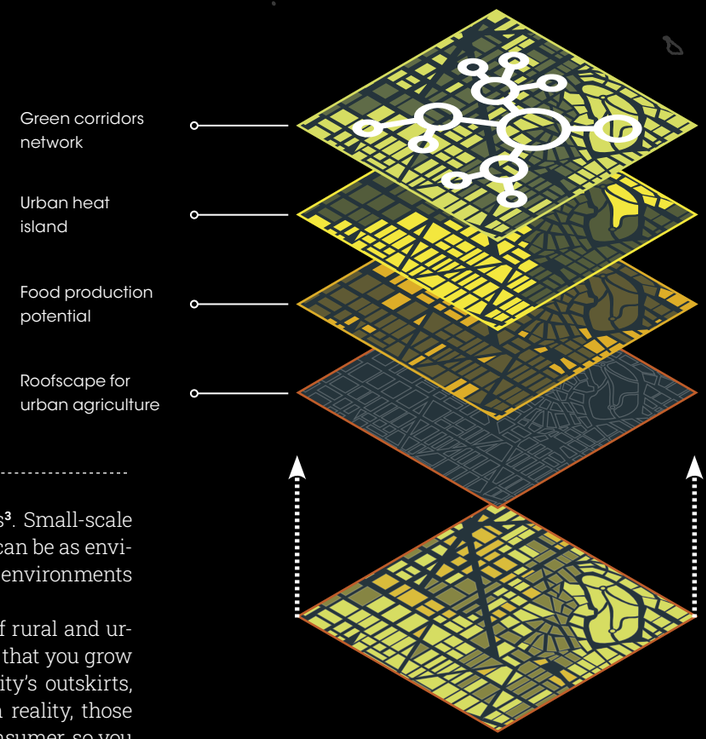
THE CITY TRANSFORMS ONLY 53% OF ITS FLAT ROOF LANDSCAPE INTO ROOFTOP GARDENS,

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.

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.



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[3]. 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.
- 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.