



BELO HORIZONTE'S GREEN-BLUE NETWORK

A MAPPING METHODOLOGY TO PRIORITIZE OPPORTUNITIES FOR NATURE-BASED SOLUTIONS

The mapping methodology presented in this case study consolidates the application of the strategic elements contained in the study of the Green-Blue Network in the Metropolitan Region of Belo Horizonte (RMBH). The process featured a multi-criteria analysis to assess local implementation sites and resulted in the mapping of priority areas to support the provision of ecosystem services in urban areas, including degraded areas

and natural areas. The main goals of this mapping process were to i) deepen the theme of ecosystem services for the technical team involved in the INTERACT-Bio Project; ii) promote engagement of actors from RMBH and iii) articulate synergies to strengthen implementation of agro-ecological practices and nature-based solutions.

The effects of urbanization on natural systems

Urbanization is one of the most aggressive drivers of change affecting the natural environment from the atmosphere to soil and water. In cities, a large part of the soil is impermeable due to the urban landscape and natural systems are often disrupted. This shows that dense urban spaces have become one of the aggravating factors concerning the effects of climate change at the local scale which also affects how ecosystem services can reach communities.

Therefore, the restoration of natural areas for the promotion of ecosystem services and the increase in biodiversity are critically important actions for local governments to focus on. The concept of nature-based solutions provides the foundation for the reintegration of natural cycles into urban design and planning, aiming to improve food security, the easy delivery of ecosystem services and thereby, quality of life for residents. [5]

With the aim of reinserting natural cycles into urban planning, the Metropolitan Region of Belo Horizonte (RMBH) has worked with ICLEI through the INTERACT-Bio project to examine the impact of the city on natural systems and develop guidelines to strengthen the integration of ecosystem services into urban areas across the region.

Ecosystem services

Ecosystem services are the benefits of nature for people. They are vital for human well-being and economic activities. Currently, three categories are considered: provision, regulation and culture.

Nature-based solutions (NbS)

Nature-based solutions are initiatives that focus on responding to urban challenges inspired and supported by nature and using or simulating natural processes.





WHAT IS THE GREEN-BLUE NETWORK?

The Green-Blue Network is one approach that was recommended by the PPDI for implementation the metropolitan region of Belo Horizonte. The original idea is to map natural areas and ecosystem services using valley bottoms as connecting elements between protected areas. These valleys and features of the landscape create natural connectivity corridors that can facilitate the protection and recovery of ecosystems degraded by the processes of urbanization. The identification and protection of these natural corridors not only increases the value of nature in urban spaces, promoting cultural and leisure activities, but can be useful for flood control.

Belo Horizonte was selected to participate in the INTERACT-Bio project in 2017. While the Green-Blue Network was already in place as an important planning guideline, it was evident that to achieve more ambitious goals, further articulated action between Belo Horizonte and the municipalities of the Metropolitan Region was necessary. The objectives of the INTERACT-Bio project – to strengthen the capacity of city-regions to integrate biodiversity and nature-based

solutions into land use, infrastructure and development planning – were in perfected alignment with the proposal of Green-Blue Network, allowing for a joint effort to strengthen the application of the network and further integrate biodiversity in the region.

The need to further develop the subject of ecosystem services in urban environments – namely to guarantee the delivery of current services and promote the development of new ecosystem services – was at the heart of the INTERACT-Bio team's work on the Green-Blue Network.

Among the action proposals for INTERACT-Bio at RMBH, the local working group identified the preservation of Conservation Units and the recovery of Degraded Green Areas as priority actions, with a focus on agroforestry systems and other types of intervention. However, given the size of the RMBH, it was important to select strategic areas that represented the overall context, opportunities, and challenges posed in the region, so the multi-criteria analysis methodology was developed to map these areas.

The multi-criteria analysis methodology

The main objective of this process was to use the Green-Blue Network alongside other mapping data and apply the multi-criteria analysis to identify priority areas to implement nature-based solutions. One key innovative aspect of the methodology used for the mapping of priority areas in RMBH is that it enables communication across scales – examining both regional and local data.

First, two maps were generated (Figure 2), one illustrating the demand for ecosystem services and the other mapping the supply.

From these maps, two main corridors of action were defined, the first is based on the conservation of nature and ecosystem services, and the other was defined by areas with major demand for ecosystem services.

Lastly, a multi-criteria analysis methodology (Figure 4) was applied to these corridors to identify priority areas for the implementation of nature-based solutions.

Three working groups were created to optimize the mapping process and activities:

- The **Mapping Working Group** was responsible for mapping green area fragments and Conservation Units within the study area.
- The **Typology Working Group** was responsible for identifying possible strategies related to the recovery of degraded areas and the promotion of ecological corridors.
- The **Mobilization Working Group** was responsible for studying social mobilization strategies in the process of implementing action on nature-based solutions.

The Mapping Working Group began by using the Normalized Difference Vegetation Index (NDVI), where fragments of vegetation that overlapped with existing Conservation Units (*Unidades de Conservação* - UCs) were identified, allowing the evaluation of potential areas of connection and creation of ecological corridors. Based on that, two corridors were prioritized, the BH-Contagem-Betim Corridor and the Serra do Curral Corridor (Figure 2).

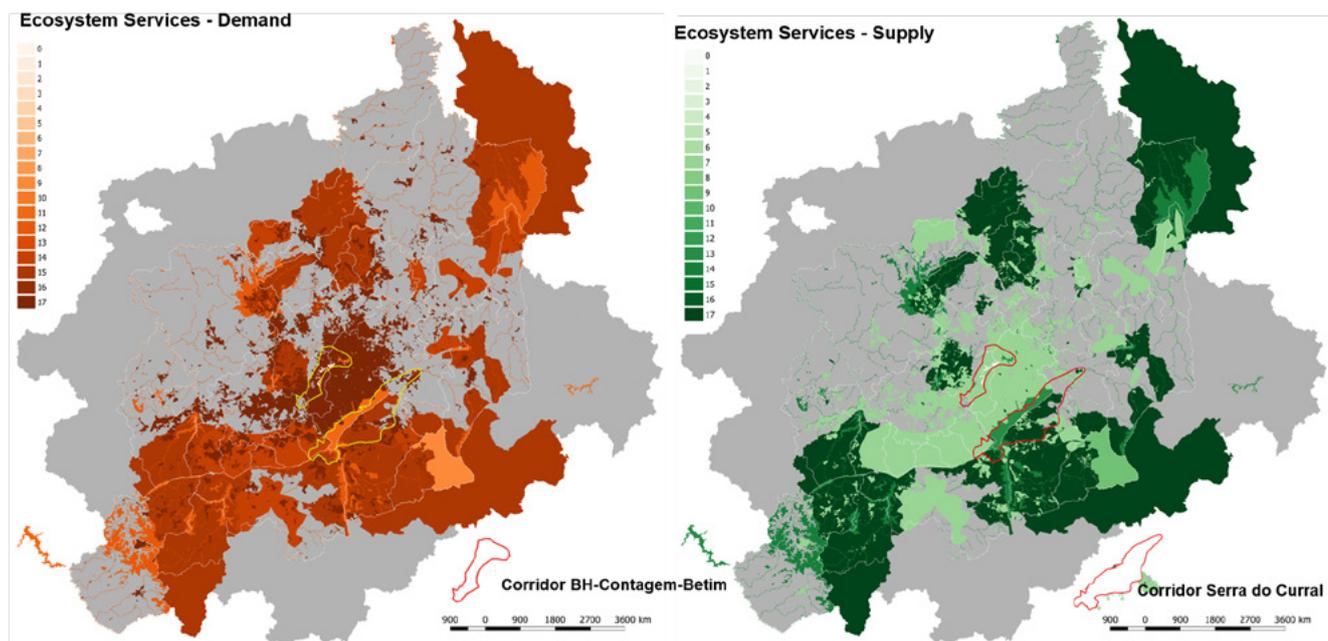


Figure 2 - Maps of Demand and Supply of Ecosystem Services in the Metropolitan Region of Belo Horizonte (1 to 7 - Low demand or supply / 8 to 14 - Medium Demand or Supply / 15 to 17 High demand or supply). Produced by ICLEI South America with the support of the Directorate of Environmental Territorial Management of SEMAD-MG and by the Foundation of Municipal Parks and Zoobotany of PBH.



From within these corridors, areas with potential for intervention were listed according to the vegetation, possibility of revegetation, and connectivity with other areas.

The next step was the evaluation of strategic areas, systematizing the following parameters: environmental attributes (APP, predominant vegetation), environmental risks (erosion, slope, flood), types of recovery (agroforestry, enrichment, total planting), and local actions (social mobilization, APP recovery, weed removal). The set of all these steps were fundamental for the composition of the multi-criteria analysis carried out under the INTERACT-Bio project in Belo Horizonte.

“From an ecological point of view, interactions are not restricted to the boundaries of municipalities and therefore the challenge is to work within the limits of geographical attributes, such as the presence of valleys and mountains, and the existence of sources of biodiversity, such as fragments of forest and green areas.”

Dany Silvio Souza Leite (2020), Director of the Belo Horizonte Municipal Environment Secretariat (SMMA)

Key actors

The State Secretariat for the Environment and Sustainable Development, the Municipal Secretariat for the Environment of the cities of Belo Horizonte, Contagem and Betim, the Belo Horizonte Municipal Secretariat for Urban Planning, Metropolitan Agency and Municipal Parks and Zoobotany in Belo Horizonte were key in implementing INTERACT-Bio.

ICLEI South America and ICLEI Africa provided technical support and experience in integrating sustainability into the urban agenda, developing project activities such as workshops and events focused on the provision of ecosystem services.

Results

- **Educational maps were produced as an awareness raising tool.** Based on the technical mapping, ICLEI is also produced an illustrated Ecosystem Services Map (Figure 3), as a more accessible tool to communicate the findings of the mapping process. This illustrated map communicates the technical concepts in a simple and visual format.

The ecosystem services mapped include the support of natural habitats, regulation of water cycle, provision of food, culture services of recreation and tourism, regulation of local climate and air quality, and moderation of extreme events. Real estate expansion, industrial zones, and mining were identified as the principle pressures threatening these ecosystem services.

- **The multi-criteria analysis methodology was used to define potential areas for implementing nature based solutions within the Green-Blue Network corridors.** This was achieved by using Normalized Difference Vegetation Index (NDVI) and other layers of analysis important to this evaluation process like land use and hydrology. Data collected in the field and satellite images were used to map the possible areas of intervention, which were further discussed. Seeking to rank the priority areas surveyed, an excel form (Table 1) was elaborated containing characteristics of the areas, organized into three major categories of information: characteristics of the area, ecosystem services and sustainability actions. These sheets were distributed to the technicians involved in the process to attribute scores, which were added to the last column, ranking the areas with the highest scores as the ideal areas for the implementation of nature-based solutions.

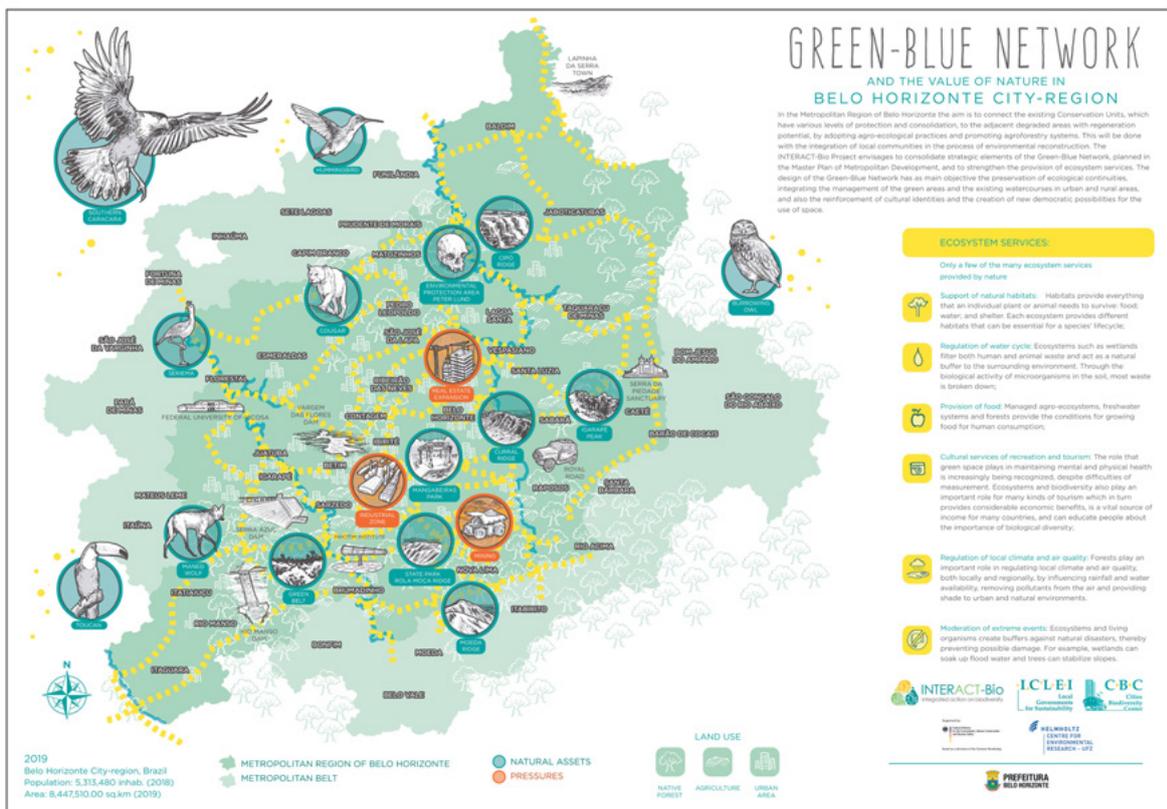


Figure 3 - Illustrated Map of Green-Blue Network and Value of Nature in the Metropolitan Region of Belo Horizonte

Importance	NOTA
High (3) Medium (2) Low (1) Does not exist (0)	
CHARACTERISTICS	
Value of protection	
Areas with socio-environmental projects	
Degraded area	
APP's	
Accessibility	
Areas with agroforestry or urban agriculture	
ECOSYSTEM SERVICES	
Water	
Food production	
Raw material production	
Medicinal resources	
Climate regulation and air quality	
Regulation of carbon sequestration	
Regulation of extreme events	
Regulation of soil erosion and fertility	
Regulation of effluent treatment	
Pollination	
Biological control	
Protection of biodiversity	
Genetic diversity	
Recreation	
Tourism	
Contemplation	
ACTIONS FOR SUSTAINABILITY	
Connectivity	
Green infrastructure	
Transformation potential in UC	
Agroforestry potential	
Social mobilization	
Institutional articulation	
Final score	

Table 1 - Multicriteria evaluation matrix of potential intervention areas in the BH-Contagem Betim and Serra do Curral corridors. Produced by technicians involved in the INTERACT-Bio project

- The results of the multi-criteria analysis table was presented at a multi-disciplinary and multi-sectoral workshop.** Participants from different areas of the municipality, metropolitan region and university were divided into groups and made a qualitative analysis of the areas presented (Figure 4). After the discussion, two main areas were selected, Mata do Confisco, in the city of Contagem and CEVAE Taquaril in Betim. After this analysis the Mata do Confisco was selected as the priority area for the implementation of nature-based solutions, as there are more interfaces already in place, especially with regard to social mobilization.
- Local technical staff were trained on the importance of ecosystem services and informed regarding alignment and synergies with other projects.** The project brought a deeper understanding of the territory and of the demand and provision of ecosystem services in the RMBH. Capacity building opportunities facilitated by ICLEI South America and partners, offered a valuable opportunity for staff to exchange knowledge and expand their thematic scope. These activities are essential to provide visibility for initiatives in the territory and to enable replication potential.





Figure 4 - Realization of the INTERACT-Bio Workshop at RMBH and choosing the priority area for promoting nature based solutions. Source: ICLEI South America

Lessons Learned

- **The multi-criteria analysis methodology was fundamental in the mapping of priority areas and in the integration of the working group.** It also promoted horizontal participation of all participants. The effort to map existing conservation areas, forest fragments and potential connection areas, and to outline the points of greatest interest for the provision of ecosystem services, reinforces the need for a metropolitan perspective as these areas go beyond municipal boundaries.
- **The engagement of different actors during the mapping process opens many opportunities for dialogue and ensures the assembly of a multidisciplinary team for the project.** The integration of regional and state agencies in the process (such as the State Secretariat for the Environment and Sustainable Development, the Municipal Secretariat for the Environment of the cities of Belo Horizonte, Contagem and Betim, the Belo Horizonte Municipal Secretariat for Urban Planning, Metropolitan Agency, Municipal Parks and Zoobotany in Belo Horizonte and the Epic-COMPASSO Extension Program of the UFMG School of Architecture) results in a project qualified technically by multiple perspectives. This diverse engagement also facilitates the implementation of more integrated initiatives.
- **The diversity of other projects in progress in RMBH promoting biodiversity in the territory (Table 1) provided both challenges and opportunities.** The articulation of these initiatives, different actors, and distinct interests was one of the challenges faced at the beginning of the project. After overcoming this challenge, through meetings of the group and expectations alignment, this point also showed to be the greatest opportunity, since during the development of the mapping a discussion was opened and the solution found covered several opportunities to further the work.
- **This mapping process was multi-level and integrated.** The mapping was conducted on a regional scale but the identification of the priority areas was made on a local scale where the nature-based solution projects will actually be implemented. Making the regional diagnosis compatible with the assessment of ecosystem services

at the local level required careful analysis, a challenging step due to the need to reconcile interests and demands for great specificity of information.

- **The integration of biodiversity and climate change agendas was one of the highlights of the process** since nature based solutions are a key part of the discussion of how to both mitigate and adapt measures to the climate crises. The investigation of how ecosystem services function in the metropolitan region allowed for more impactful decision making regarding which initiatives could best promote biodiversity and local action for nature while also increasing resilience.
- **The opening of new actions was made possible through discussions raised by the diverse stakeholders involved.** The work in partnership with UFMG's Epic-COMPASSO Extension Program enabled outcomes such as the mapping of possible backyards for planting fruit trees, linking existing green areas with already consolidated urban environments.
- **Implementation of long-term goals is one of the aspects foreseen by the mapping process,** which should occur despite possible changes in the political scenario or composition of the technical staff.

After the completion of the first projects foreseen by the initiative, it is necessary to involve the interested parties to keep monitoring, discussing and adjusting new objectives and establishing new cooperation agreements anchored in regional political initiatives.

"I believe that in view of our construction process, three experiences stand out and can be used as a reference for other municipalities: 1) Before thinking about the selection of areas, an important thing is to start by surveying the key problems that need to be faced in the municipality, either as whole or even part of the territory. 2) Another point that goes beyond the geo-referencing of strategic locations is to carry out on-site visits to learn about details that can make a difference in the process of choosing strategic areas. 3) And finally, it is the involvement of a multidisciplinary team, whose ability to complement views and knowledge can improve the process of selecting areas."

Dany Silvio Souza Leite (2020), Director of the Belo Horizonte Municipal Environment Secretariat (SMMA)



Replication Opportunities

The case study presented has a high replication potential, since the data collection and analysis method can be adapted according to the geographic location and specificities of each city or region. Therefore, for the initiative to take place in a more structured and qualified way, it is important to mobilize the local actors who will be involved with the project development.

In the case of the Metropolitan Region of Belo Horizonte, meetings were held to integrate the interdisciplinary technical staff, from various institutional sectors, and to level the content in relation to Ecosystem Services, since it is the one of the main focus and perspectives promoted by the INTERACT-Bio Project. In addition, UFZ offered training workshops and tools to improve and gather knowledge about ecosystem services to support the technical staff that participated in the project.

The methodology for mapping priority areas for the provision of ecosystem services that was presented and described in this case study text, was conducted over a period of six months. The involvement of a multidisciplinary work team was indeed important for the success of its implementation, since looking at a topic from different perspectives mitigates the chances of failures and qualifies the process and outcomes.



References

- [1] Agência Metropolitana RMBH. (2016) RMBH e colar metropolitano. Belo Horizonte, Agência de desenvolvimento da Região Metropolitana de Belo Horizonte. Disponível em: <<http://www.agenciarmbh.mg.gov.br/institucional/rmbh-e-colar-metropolitano/>> Acesso em Junho de 2020.
- [2] Instituto Brasileiro de Geografia e Estatística (IBGE). (2019). Estimativas da População. Disponível em: <<https://www.ibge.gov.br/estatisticas/sociais/populacao/9103-estimativas-de-populacao.html?=&t=downloads>> Acesso em Julho de 2020
- [3] Prefeitura Municipal de Belo Horizonte (PBH) . (2013). 2º Inventário de Emissão de Gases de Efeito Estufa. Belo Horizonte, Secretaria Municipal de Meio Ambiente de Belo Horizonte.
- [4] OKE, T. R. (1973) Evapotranspiration in urban areas and its implications for urban climate planning. In: Conference Teaching the Teachers on Building Climatology. Estocolm: The National Swedish Institute for Building Research.
- [5] BAUDUCEAU, Nicolas et al. (2015) Towards an EU Research and Innovation Policy Agenda for Nature-based Solutions & Re-naturing Cities: Final Report of the Horizon 2020 Expert Group on 'Nature-based Solutions and Re-naturing Cities'.
- [6] REZENDE, V. L. (2016). A mineração em Minas Gerais: uma análise de sua expansão e os impactos ambientais e sociais causados por décadas de exploração. Sociedade & Natureza.
- [7] SILVA, A. et al. (2010). SWITCH in Belo Horizonte, Brazil: Infiltration and detention systems for more sustainable stormwater control in Belo Horizonte. Environmental Science and Biotechnology.
- [8] SOARES, Thiago Leonardo et al. (2011) Zoneamento morfológico-funcional da Região Metropolitana de Belo Horizonte e estágio de desenvolvimento econômico de seus municípios. Anais ENANPUR, v. 14, n. 1.
- [9] Plano Metropolitano RMBH. (2016). Região Metropolitana de Belo Horizonte. Disponível em: <<http://www.rmbh.org.br/>> Acesso em Junho de 2020.
- [10] OLIVEIRA, Ana Mourão; COSTA, Heloisa Soares de Moura. (2018). A trama verde e azul no planejamento territorial: aproximações e distanciamentos. Revista Brasileira de Estudos Urbanos e Regionais.



Appendix

Related initiatives and actions

Type of action	Description
Regulation	Master Plan In 2019, the new Master Plan for the city of Belo Horizonte, Law nº 11.181 / 19, which has been in progress since 2015, was approved. One of the guiding points of this new plan concerns the recovery and preservation of the municipality's environmental heritage, seeking to maintain and recover green areas and the enhancement of water bodies.
Capacity building	Workshop "Biodiversity, Ecosystem Services and Metropolitan Management" - Metropolitan Region of Belo Horizonte The workshop was facilitated in 2018 by specialists from the Helmholtz Environmental Research Center (UFZ), who promoted activities to develop the understanding of ecosystem services, demonstrating through activities how to map and identify the provision of these services and develop suitable indicators for monitoring and evaluation of Ecosystem Services in the territory.
Awareness-raising	Illustrated Maps From the mapping of ecosystem services (Figure 2), an illustrative map (Figure 3) was produced describing the different categories of services in the region, the main areas of demand and supply of these services and the regional fauna. This map was used as a tool for the wide dissemination of content to different audiences. It is available on the INTERACT-Bio online platform and was also physically distributed at events and meetings. " BIO2020 Brazilian Perspectives in the Post-2020 Biodiversity Framework", in 2020 in São Paulo, Brazil, was a fundamental event for inputs and contributions from local governments to international policy planning. It was also important for the progress towards COP. Also in BIO2020 a meeting between Campinas, Belo Horizonte, Londrina, Ministry of Regional Development, state of São Paulo and ICLEI Africa.
Technical and technological measures	Geodesign Workshop - Confisco Technical/Academic The Workshop was conducted by the team of the UFMG Extension Project Epic-COMPASSO and counted with the participation of INTERACT-Bio's technical representatives for RMBH for testing the application of Geodesign, a tool for co-creating projects for the local landscape. Participation was important for the recognition of the area that was mapped as one of the priorities for the provision of ES. CitiesWithNature The city of Belo Horizonte was one of the first cities to sign CitiesWithNature , a shared online platform for cities to connect and have access to international experiences related to the integration of nature into cities.
Technical and technological measures	Demonstration Projects In order to better understand and specify the benefits provided by investing in nature-based solutions, especially with regard to the water cycle, a demonstration project in the region will be developed. Rain gardens will be implemented to demonstrate and give visibility to the potential of Nature Based Solutions and aiming at the possibility of replicability.

Acknowledgements

Author

Marília Israel de Azevedo Borges, *ICLEI South America*
Sabrina Maria de Lima Accioly, *DGTA/SEMAD*

Contributors

Larissa Miranda Heinisch, *ICLEI South America*
Sophia Picarelli, *ICLEI South America*
Sandrine Giancristófaró Gouvêa, *ICLEI South America*
Dany Silvio Souza Leite Amaral, *SMMA/PBH*
Fabrício Lisboa Vieira Machado, *SEMAD*

Design

Olga Tokareva, *ICLEI World Secretariat*

Contact Info

ICLEI Cities Biodiversity Center

Unit 1, 2nd Floor, South Tower, Sable Park, 14 Bridge
Boulevard, Century City, Cape Town, 7441

Tel: +27 21 202 0381

Email: biodiversity@iclei.org

<https://cbc.iclei.org/>



This project was funded by the German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) through the International Climate Initiative (IKI). Support from the Helmholtz Environmental Research Center (UFZ) was also essential, especially in the technical aspects of the project, such as the development of workshops and training meetings, as well as the ICLEI Africa / Cities Biodiversity Center. Human resources from ICLEI South America and municipalities in the RMBH, as well as mobilization for meetings (travel and events), were the main financial categories of the process. Support was also provided by the German International Cooperation Agency (GIZ).

Partners



ICLEI – Local Governments for Sustainability is a global network of more than 2500 local and regional governments committed to sustainable urban development. Active in 125+ countries, we influence sustainability policy and drive local action for low emission, nature-based, equitable, resilient and circular development. Our Members and team of experts work together through peer exchange, partnerships and capacity building to create systemic change for urban sustainability.

The INTERACT-Bio project is supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) through the International Climate Initiative (IKI).

Supported by:



based on a decision of the German Bundestag