Key Data-Driven Tools for Integrated Climate Action in the City of Belo Horizonte, Brazil

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The City of Belo Horizonte is implementing public mitigation policies, adaptation measures to climate change, and improving attempts to reduce GHG emissions and their effects on local and global warming. Data analysis, collection, and monitoring are a basis for Belo Horizonte's climate action plan. Belo Horizonte is an example of how cities can use data to ensure precise, supervised, and effective climate action.

Introduction

Local governments are increasingly developing policies and programs designed to adapt, mitigate, and become resilient to climate change. Growing commitments and engagement in climate governance generate new dimensions of monitoring and evaluating climate action. Thus, there are new sources and uses for data support on city climate action strategies and data-driven decision-making. Greenhouse gas (GHG) emission inventories, mitigation targets, risk and vulnerability assessments on global data platforms are some examples of data that are increasingly seen as core components of effective climate change policy and planning from local governments. This case study explores how Belo Horizonte uses data to strategize, monitor, and evaluate the city's climate actions (See Figure 1).

Figure 1 – Ortho Belo Horizonte Map 2015, BHMap© [6]

Facts & Figures

Population (2020)
2,501,576

Area
331.401 km^2

GHG Emissions (2019)
4.16 Mt CO_2e

Average temperatures
17.8 - 27.2 (°C)

Average precipitation
1,602.6 mm (per year)

GHG emissions inventory as a policy instrument for climate action

Belo Horizonte's Municipal Secretariat for the Environment (SMMA) has published four editions of GHG emissions inventories, which account for their emissions, and collect related data since the year 2000 (See figure 2) [1]. The GHG emissions inventory of Belo Horizonte constitutes a key policy instrument to enable self-assessment of emissions, impacts and trends. Each inventory includes sectoral emissions and proposed actions to achieve the city climate action goals. SMMA developed the city's first inventory in 2009, accounting emissions for the years 2000 to 2007. Currently, the fourth edition reports data for the period of 2014 to 2019, and includes a review of the data collected from 2009 to 2013 to align with the accounting methodology [1]. Along the 20 years of emissions monitoring and reporting in Belo Horizonte, much progress has been made in the methodological calculation and development of the GHG emissions inventories.

The latest inventory uses local emission factors, moving away from default global factors, and increasing data accuracy when calculating the GHG emissions for the city. Milestones and amendments were established to align each inventory to the most recent reporting and accounting methodology to allow data comparison. This includes training different stakeholders involved in the data collection process to guarantee reliable and accurate data is available for aggregation. Likewise, additional important data-driven decisions based on the results of the GHG emissions inventories included the exclusion of emissions related to land use change, as they proved to be irrelevant in the first inventory. For this reason, this parameter is not evaluated in current inventories, allowing the local government to focus their efforts in the priority areas. The Municipal Committee on Climate Change and Eco-efficiency (CMMCE), integrated by multiple sectoral and organizational representatives, handles validating and analyzing the data

> *"Belo Horizonte has one of the largest historical data series of Greenhouse Gases emissions in Brazil, accounting for the emissions of the past 20 years."*
>
> - Sonia Knauer, Municipal Secretary of Environment, City of Belo Horizonte, Brazil

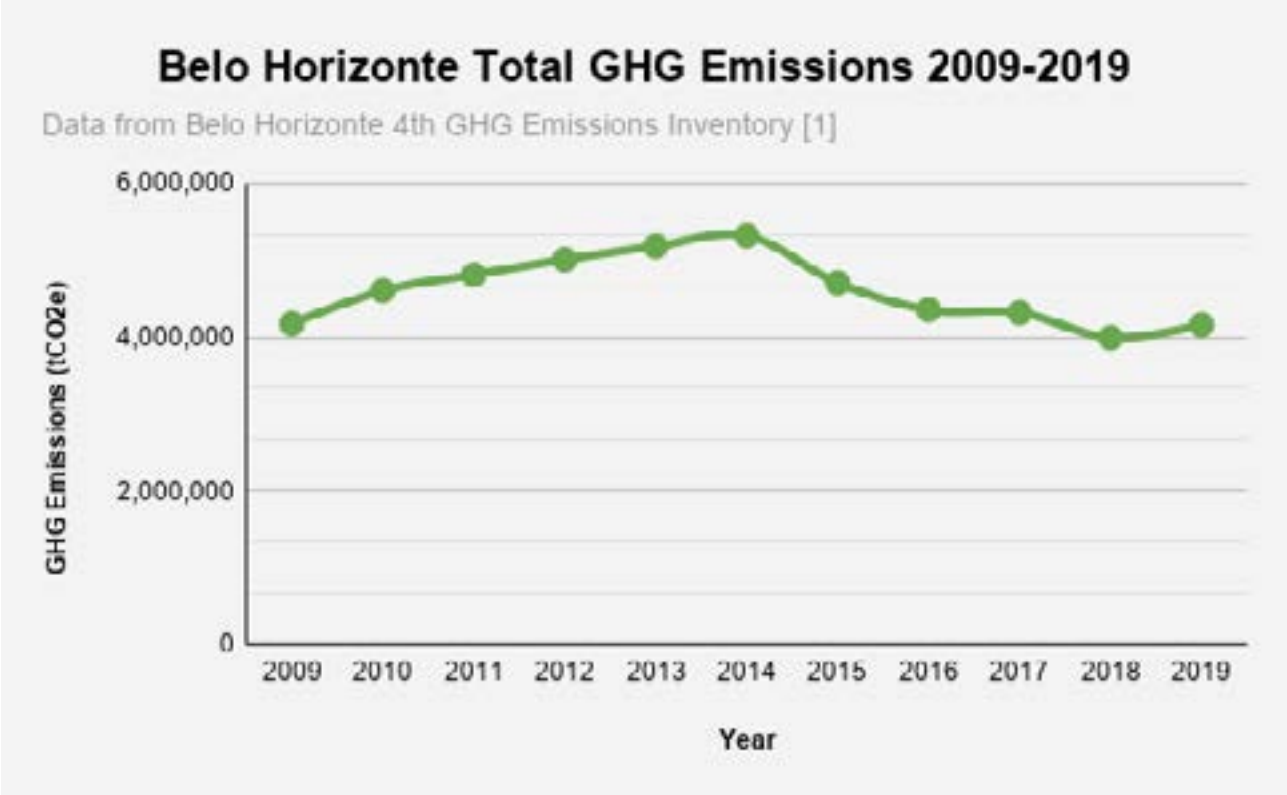

Figure 2 – Belo Horizonte total GHG emissions 2009-2019 [1]

collected by SMMA with the assistance and support of WayCarbon, a private environmental management consultancy company [2]. Through WayCarbon's sustainability indicators management system *"CLIMAS"*, Belo Horizonte calculates GHG emissions and analyzes data to track their mitigation targets and establish their emissions profile. However, access to the platform is exclusively for the technical team that operates the inventory, but can also be made available to other relevant stakeholders or the community upon request. To ensure the reliability of the inventory, Belo Horizonte's *CLIMAS* platform was created based on the internationally recognized Global Protocol for Community-Scale GHG Emissions Inventory (GPC), which allows to not only report emissions disaggregated by sectors and subsectors, but also gives a comparative analysis.

The GPC is based on five core principles [3]:

- Relevance of GHG emissions data
- The inclusion of all the GHG emissions within the chosen area, consistency in techniques of data collection
- Quantification and analysis
- Transparency and accuracy

Table 1 summarizes the scopes, sectors, and subsectors for which the emissions are accounted for in Belo Horizonte's inventory. Scope 1 corresponds to direct emissions from fuel combustion. Scope 2 refers to indirect emissions from energy consumption from local, regional, or national supply. Scope 3 includes emissions from outside of Belo Horizonte's geopolitical boundaries.

Table 1 - Sectoral GHG Emissions Evaluated by Sources

Sector	Sub-Sectors	Scope	Source
Energy Stationary Sources	Residential	Scope 1	Liquefied Petroleum Gas (LPG) and Natural gas
		Scope 2	Electricity
	Commercial and institutional	Scope 1	Diesel, LPG, Natural gas, and Fuel oil
		Scope 2	Electricity
	Industry	Scope 1	Diesel, LPG, Natural gas, and Fuel oil
		Scope 2	Electricity
Transport	Land Transport	Scope 1	Diesel, LPG, Compressed Natural Gas (CNG), Kerosene, Hydrous ethanol, Petrol, and Fuel oil
	Aviation	Scope 1 & 3	Aviation gasoline
Waste	Disposal of solid waste	Scope 1 & 3	CH_4, N_2O
	Biological treatment of waste	Scope 1	CH_4
	Wastewater treatment and discharge	Scope 1	CO_2

Data on waste is collected and categorized by type of treatment and final destination, such as landfill, biological treatment, and energy recovery. Currently, Belo Horizonte has two energy plants for methane (CH_4) reduction and electricity generation using biogas from the landfill.

> The energy generated from biogas in Belo Horizonte is enough to supply around 20,000 households with an electricity consumption of less than 100 KWh/month.

With the GHG emissions inventory, Belo Horizonte has been able to not only define locally based climate actions, but also data-driven policies and programs. In 2013, the city developed their first GHG Emissions Reduction Plan (Plano de Redução de Emissões de Gases de Efeito Estufa, PREEGE) based on the results of the GHG emissions inventories reported from 2008 to 2010, and the identification of priority sectors [4]. The plan responds to the three key sectors: Energy, Transport, and Waste; and is integrated in three main categories - mitigation actions, results, and monitoring indicators. For example, after reviewing the GHG emissions data, the transport sector was identified as a priority sector since it accounted for 56 percent of the total GHG emissions in the city (See Figure 3). Therefore, the PREEGE establishes a target to reduce 24 percent of the transport emissions by 2030. The interpretation of this data allowed the local government to outline specific mitigation actions and monitoring indicators focused on the transport sector, influencing the implementation and monitoring of public policies in Belo Horizonte (See table 2) [4]. The timeframe for the implementation of each action is defined as short (2015), medium (2020) or long term (2040), according to its priority and ease of implementation.

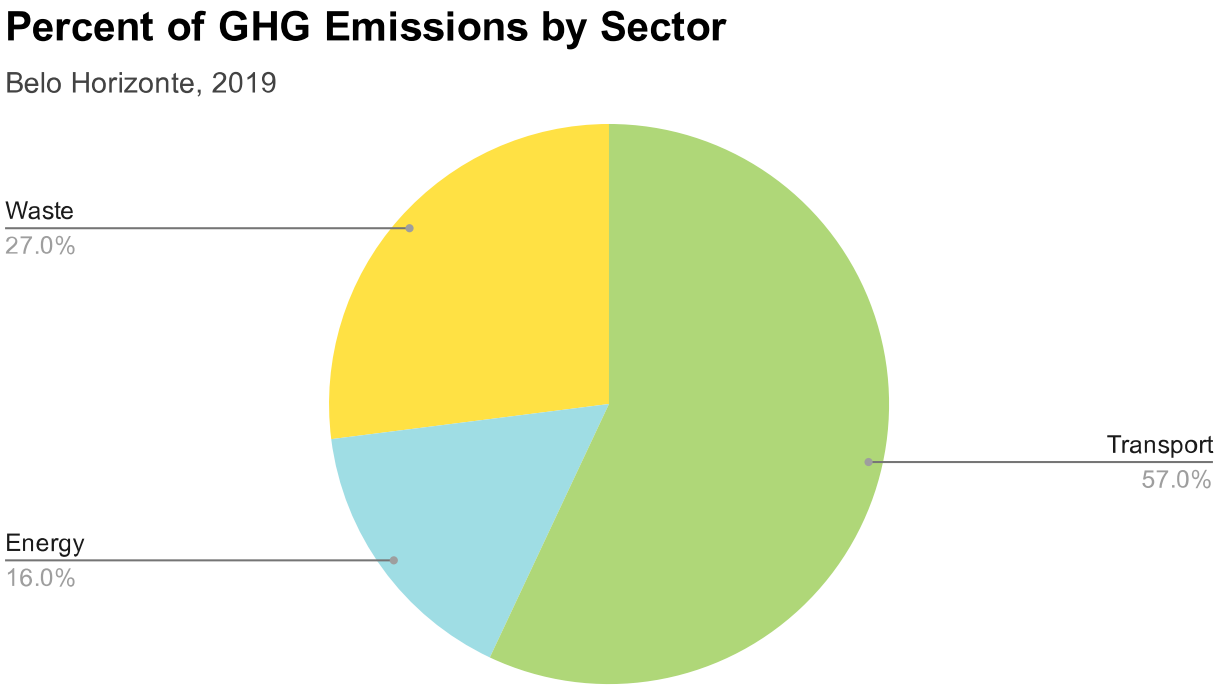

Figure 3 – Percent of GHG Emissions by Sector in Belo Horizonte, ICLEI©

Table 2 - Examples for Transport GHG Emissions Reduction Actions and Indicators from Belo Horizonte's PREEGE [4]

Action	Monitoring Indicator	Estimated Time
Monitoring and quarterly evaluation of the condition of the cycle infrastructure (cycle paths and lanes) in the city and the repair of damaged roads.	• Total kilometers of monitored cycling infrastructure. • Kilometer percent of monitored cycling infrastructure. • Kilometer of repaired cycling infrastructure.	Medium term
Extend the range of exclusive bus lanes, ensuring exclusive lanes in all streets that receive more than three bus routes.	• Kilometers of exclusive lanes implemented.	Medium term
Supply, when possible, the entire fleet of vehicles of the municipal public administration with less polluting fuels.	• Number or percentage of fleet vehicles supplied with less polluting fuels. • Consumption (L) of ethanol by PBH vehicles. • Consumption (m^3) of CNG, or biogas by PBH vehicles.	Long term

The importance of a vulnerability assessment for climate change adaptation

In terms of the data usage for evaluating adaptation measures, Belo Horizonte developed a Climate Vulnerability Study in 2016 based on the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (AR4-IPCC, 2007), it serves as a tool for decision-making, risk assessment and planning. The formulation of the vulnerability index relies on available information of climate change risk exposures, combined with the socio-environmental sensitivity to these changes, and the ability of the urban system to respond and adapt to extreme conditions. Vulnerabilities and adaptability were estimated using the Model Vulnerability Evaluation (MOVE), an integrated cloud-based platform that uses spatial and statistical analysis to assess vulnerabilities associated with climate change in cities [5]. The data is georeferenced and mapped on an open geoprocessing-portal called BHMap, which is operated by Prodabel's Corporate Geoprocessing Superintendence in Belo Horizonte [6]. The maps provide open access to information and tools for general use [6]. The analysis of these maps enabled Belo Horizonte to prioritize intervention by identifying the highest vulnerable areas of the city. The vulnerabilities related to climate change in the city were estimated by different vulnerability and adaptability indicators; associated with floods (Figure 4), landslides, vector transmissible diseases (e.g. Dengue fever) and heatwaves. This was done using existing data of 2016 and scenarios projected for 2030 developed by the National Institute for Space Research (ETA-HadGEM2-ES - CPTEC-INPE) [7].

To identify and evaluate climate change risks and hazards, Belo Horizonte uses meteorological data, such as rain and stream levels, numerical weather forecast models, synoptic charts, atmospheric surveys, and weather satellites. The weather data generates parameters for interventions related to rainwater urban drainage, macro and micro drainage, as well as emergency actions due to heavy rain that has been known to cause floods. The continuous monitoring of rainfall data allows the city to manage platforms for flood warnings. For example, The Rain Alert Nucleus (NAC) is a civil defense system created by citizens that oversee alerting, monitoring and guiding people who work in areas at risk for flooding. An important

warning tool to support risk management is the Public Warning Disclosure Platform (IDAP), the registration is free, and citizens receive preventive weather alerts via text message to their mobile phones. The tool promotes public preparedness and awareness of climate change hazards.

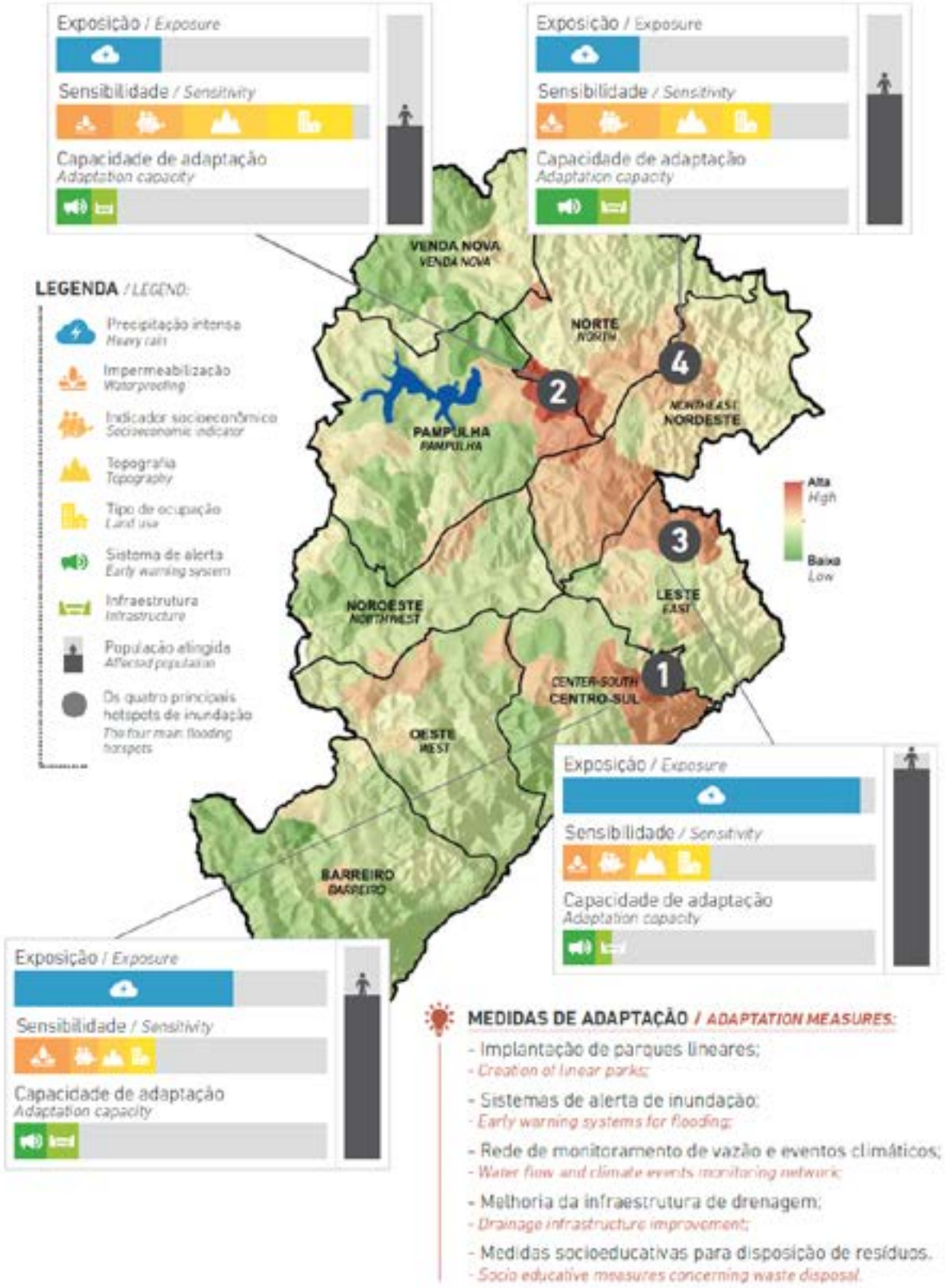

Figure 4 – Flooding Vulnerability Profile in the Municipality of Belo Horizonte in 2030© [7]

Figure 5 – Belo Horizonte, Divulgação/PBH©

Funding opportunities based on climate data

Climate data is important when it comes to Belo Horizonte's financial decisions. The city focuses on three main aspects to finance integrated climate action: resources of the public budget, promotion of incentives for a sustainable economy, and raising funds from international projects.

For example, most of the local government's investments from public funds, related to rain drainage infrastructure, were implemented based on climate monitoring of rainfall and runoff analysis.

Belo Horizonte promotes a Green Economy Plan, which encourages companies to develop sustainability actions in the city, such as collecting and recycling glass to reduce the volume of waste in the municipality. To help companies with a sustainable development transition, in 2012 an environmental certification called the Sustainable BH Seal was launched. SMMA created a simulator capable of testing different combinations of technologies to assist companies that might be interested in receiving the Sustainable BH Seal certification. This simulator provides an economic incentive for innovation, by helping companies optimize the cost-benefit ratio of implementing environmental changes [8].

Additionally, in relation to international funds, the city used climate vulnerability and GHG emission data to support the acquisition of a loan for the World Bank project of Improvement of Urban Mobility and Inclusion in the Corridor Amazonas in Belo Horizonte [9]. This loan will be given for urban improvements in a non-formal, low-income neighborhood, called *Vila Cabana do Pai Tomás*. The resources will also support the implementation of a mass transportation system (Amazon Express Bus Corridor), including new stations and bus stops, renovation of sidewalks, and equipment and technology to support the operation of the bus lane. These investment opportunities are aligned with the key sector identified in the inventory, and therefore will help reduce GHG emissions from the transport sector and promote sustainable transportation methods. Moreover, as a satellite city of the Urban-LEDS II (Urban Low Emissions Development Strategy) project and through the LEDS Lab initiative[1], Belo Horizonte received technical support to develop bankable projects related to climate action, focused on the energy sector. As a result, the city will conduct energy consumption assessments and use this data

1 LEDS Lab is an ICLEI initiative under the Urban LEDS II project, launched in 2019 as a laboratory for supporting cities to develop bankable climate related projects.

to plan energy efficiency measures in public schools and governmental buildings as a pilot project [11][12].

Lessons Learned

Data is critical to the City of Belo Horizonte's climate action and adaptation planning. The following lays out the main insights from this case study:

- The GHG emissions inventory is an important data-driven policy instrument for climate action. It can aid cities and local governments to formulate and track integrated climate action goals, to generate buy-in from relevant stakeholders, and to identify economic opportunities. In addition, GHG emissions inventories help decide which sectors should be particularly monitored and provide a baseline for emission reduction strategies.
- Collaboration across sectors and between municipal committees for collecting and analyzing data, guided by an external expert, was an efficient way for Belo Horizonte to define and manage their GHG emissions and related monitoring indicators.
- The compilation of a GHG emission inventory should be a regular process to guarantee reliable and continuous historical datasets to support related decision-making processes.
- Applications of international methodologies, such as GPC and IPCC guidelines, support a coordinated and standardized process for GHG emissions data collection, monitoring, reporting and verification. Moreover, these methodologies allow global data comparability and assist on how to interpret the collected data to set indicators. Trained staff and official data sources are essential to develop an accurate and reliable GHG emissions inventory. Key stakeholders and data holders must also take ownership of the inventory and understand their role and responsibilities in the process.
- Data displayed on publicly available and downloadable maps is an efficient way to inform citizens about climate change risks and vulnerabilities, as well as to encourage community involvement in adaptation programs and community-based monitoring.
- A consistent historical database allows for the evaluation of data trends, accuracy and relevance for aggregation and further analysis. After several years completing a GHG emissions inventory with different methodologies, Belo Horizonte recognized the need to update all the inventories and aligned the methodologies for GHG emissions calculations to enable data comparison. Thus, the evaluation of the progress achieved by their mitigation actions implementation.

These insights are important for local governments to understand how data presents possibilities to support the achievement of climate commitments on mitigation, adaptation, and resilience.

Figure 6 – Belo Horizonte, Divulgação/PBH©

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