

# Policy Brief

## **Challenges and perspectives for monitoring air quality in the Legal Amazon:**

**An integrated vision regarding technologies, social and environmental contexts, and public policies**



respira  
**AMAZÔNIA**



# respira AMAZÔNIA

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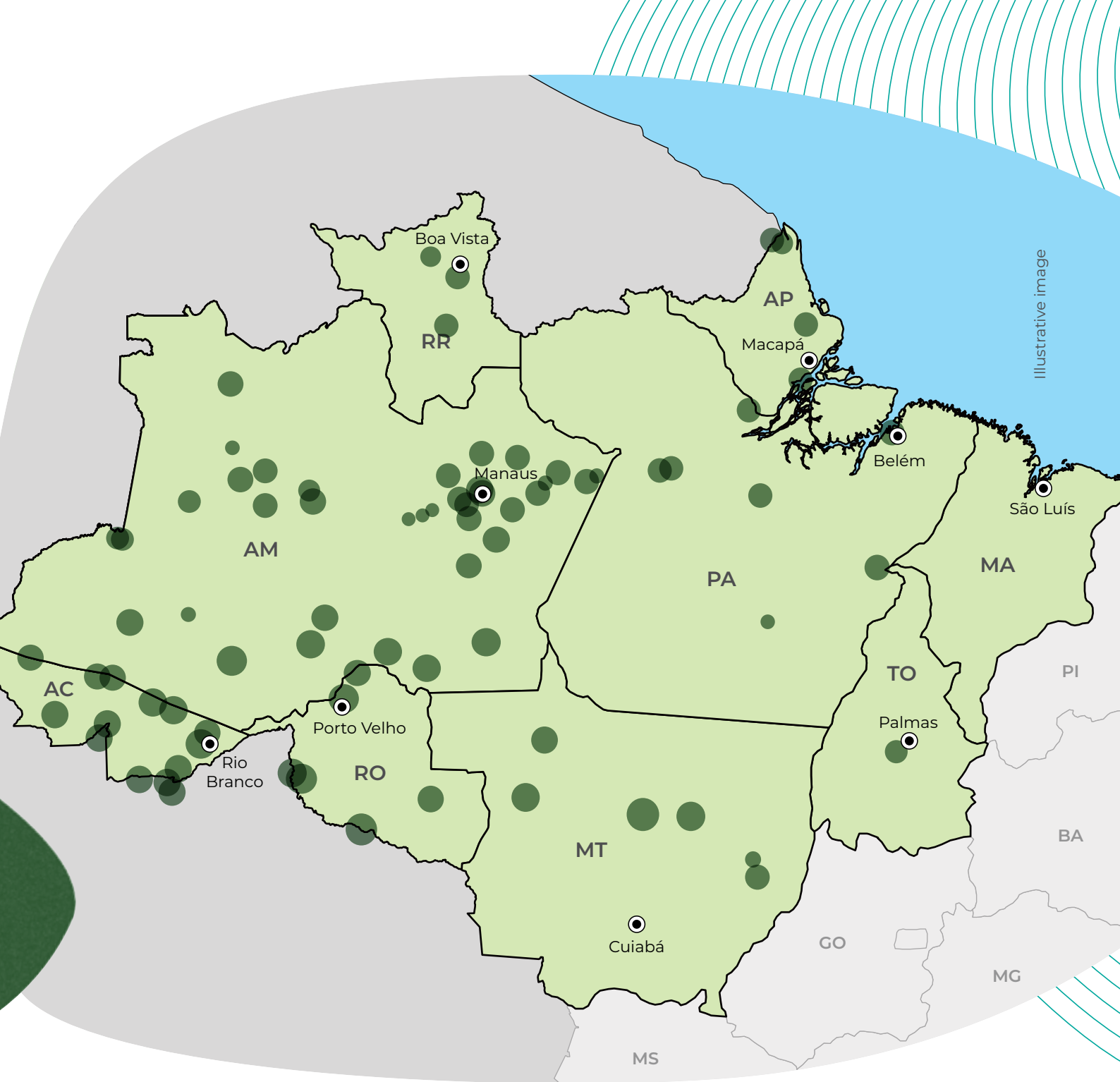
# About the Respira Amazônia Coalition

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The Respira Amazônia Coalition is an innovative initiative that brings together public and private entities and civil society organizations to promote air quality monitoring in the Legal Amazon, a region that faces a severe lack of data and localized information due to the scarcity of reference equipment. Focused on the use of low-cost sensors and integration with other technologies, the general goal of the Respira Amazônia Coalition is to encourage the expansion of monitoring, especially in hard-to-reach areas where infrastructure is limited. To encourage more effective environmental policies and strengthen the response to climate challenges, the initiative seeks to increase awareness and capacity for action in the region, thus protecting public health and the environment.

To date,  
**187 sensors**  
are managed by partners  
of the Respira Amazônia  
Coalition in the region.

The Respira Amazônia Coalition prepared this policy brief to offer a comprehensive view of air quality monitoring in the Legal Amazon and highlight the innovative role of low-cost sensors. This document presents the region's current context, its main



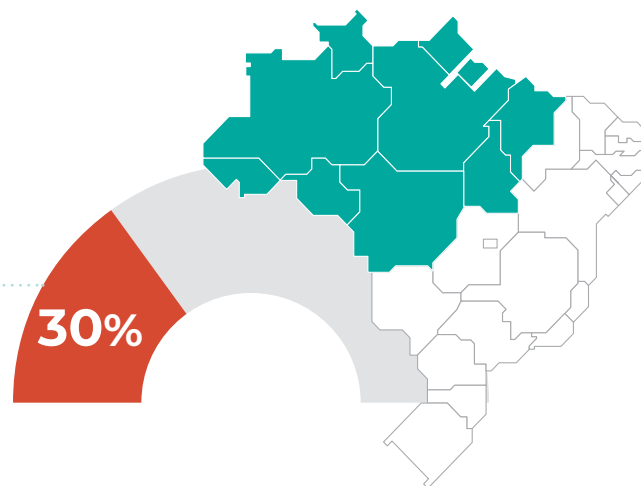
challenges and opportunities, and existing initiatives using these technologies to collect real-time data on air quality. Furthermore, it discusses the benefits of integrating this data with traditional monitoring systems, the implications for decision-making, and the formulation of

more effective public policies for quality management. Through concrete examples, the policy brief illustrates how these technologies contribute to improving the population's health, protecting the environment, and strengthening the participation of civil society in environmental management.

# Abstract

According to the World Air Quality report, of the 38 Brazilian cities with the worst air quality in 2023, 13 are located in the Legal Amazon, representing around **30% of the total**. Air pollution in the Amazon, driven mainly by fires and agricultural expansion, has devastating environmental and public health impacts. The use of fire, a traditional soil management technique, is now out of control, releasing large amounts of harmful pollutants, such as suspended particles, carbon monoxide, and others. This scenario affects rural areas and urban centers, where industrial and transport emissions add to fires' pollution and worsen air quality.

Despite the passing of the new National Air Quality Policy (Law No. 14850) in 2024, implementing monitoring systems in the Legal Amazon faces several challenges. The infrastructure needed to install and manage such systems is insufficient in many regions, and most states lack technically qualified professionals to operate this equipment effectively. The lack of continuous monitoring makes it difficult to respond to pollution spikes, especially during



the burning season when pollutant levels increase dramatically. In this context, low-cost sensors emerge as a viable alternative to expand the monitoring network, especially in remote and difficult-to-access areas. These sensors are a practical and more affordable solution that allows broader data collection, which is key for developing effective strategies and policies against air pollution, fires, and deforestation. Although they have lower accuracy than reference sensors, the fact that they are easy to install and maintain makes these devices more suitable for regions with limited resources and contribute significantly to the region's environmental monitoring coverage.

Although low-cost sensors are a viable solution for monitoring

air quality in remote areas, using integrated technologies is essential to ensure comprehensive coverage in the Legal Amazon. Low-cost sensors have limitations, such as lower precision, reduced durability, the need for validation against reference equipment, and frequent maintenance and cleaning. Therefore, combining these technologies with others, such as satellite monitoring and modeling, is key to filling the gaps left by isolated sensors. Investing in research to improve the accuracy of data generated by such devices and expanding the use of additional solutions will allow the development of a more effective monitoring network, especially in

areas where installing traditional equipment is unfeasible. This way, obtaining more reliable and comprehensive data to support public policies and strategies to combat air pollution will become possible.

Several initiatives driven by citizens and institutions are being implemented to address the lack of air quality monitoring in the Amazon. Between 2019 and 2021, with the support of the Public Prosecution Office of Acre and the Federal University of Acre, a network of low-cost sensors was installed in 22 municipalities, focusing mainly on monitoring during the burning period.





**Collaboration  
between different  
actors, such as  
researchers, public  
managers, and local  
communities, is vital  
for the success of  
initiatives that aim to  
expand and improve  
air quality monitoring  
in the Amazon.**

In Amazonas, the SELVA Platform, launched in 2021, integrates data on atmospheric pollution and fire outbreaks and serves as an important tool for environmental monitoring and education. Between 2021 and 2024, researchers from the Woodwell Climate Research Center and the Amazon Environmental Research Institute (IPAM) installed 60 low-cost sensors across the nine states of the Legal Amazon, thus expanding the air quality monitoring network. In 2023, the Biodiversity Protection and Conservation Network through Technologies (Redt Amazonas), in partnership with South Korea, began installing 100 sensors to monitor air quality, connected to the SELVA Platform, to combat deforestation and improve environmental management. These initiatives were integrated by the Respira Amazônia Coalition, also created in 2023, uniting public and private entities to expand monitoring with accessible technologies and strengthen policies aimed at environmental protection and public health.

While researchers ensure the accuracy of the data collected, public managers use the information to create policies that protect the most vulnerable populations. Active involvement of communities, especially in remote areas, is vital to disseminate this information and promote local awareness. Therefore, overcoming the logistical and technical challenges of monitoring requires continuous investment in infrastructure and research, as well as cooperation between the public and private sectors. Only through this collaboration will it be possible to formulate effective policies that protect the health of the population and preserve the Amazon ecosystems.

# The territory of the Legal Amazon

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The Legal Amazon, which covers nine Brazilian states (Acre, Amapá, Amazonas, Maranhão, Mato Grosso, Pará, Rondônia, Roraima, and Tocantins) and 772 municipalities, corresponds to approximately 58.9% of the national territory, totaling approximately 5 million square kilometers.<sup>1</sup> This vast region plays a vital role in regulating the global climate and preserving biodiversity, and is one of the most important ecosystems on the planet.

However, despite its ecological importance, the Amazon has been facing increasing levels of air pollution, largely resulting from fires set to remove native vegetation, mainly due to agricultural expansion. According to the National Institute for Space Research (INPE), fire outbreaks in the Legal Amazon increased by 96% between September 2023 and September 2024.<sup>2</sup> The location of these outbreaks, as well as the deforested areas, directly reflects the expansion of the agricultural frontier, involving activities such as logging, converting forests into pastures, and the intensive cultivation of grains such as soybeans, corn, and rice.<sup>3</sup> These practices, in addition to contributing to deforestation, are also responsible for increasing air pollution and affect biodiversity and communities that depend on the forest.

01

Brazilian Institute of Geography and Statistics (IBGE).  
Amazônia Legal (Legal Amazon).  
**Available at:** <<https://www.ibge.gov.br/geociencias/cartas-e-mapas/mapas-regionais/15819-amazonia-legal.html>>.  
**Accessed on:** October 3, 2024

02

National Institute for Space Research (INPE).  
Programa Queimadas, 2024.  
**Available at:** <[https://terrabrasilis.dpi.inpe.br/queimadas/situacao-atual/situacao\\_atual/](https://terrabrasilis.dpi.inpe.br/queimadas/situacao-atual/situacao_atual/)>  
**Accessed on:** October 3, 2024

03

Brazilian Institute of Geography and Statistics (IBGE).  
Fronteira Agrícola - Amazônia Legal.  
**Available at:** <<https://www.ibge.gov.br/geociencias/cartas-e-mapas/mapas-regionais/15976-fronteira-agricola-amazonia-legal.html?=&t=o-que-e>>  
**Accessed on:** October 3, 2024



Burning large forest areas releases high volumes of particulate matter and toxic gases that profoundly impact human health and the environment. According to the World Air Quality report,<sup>4</sup> of the 38 Brazilian cities with the worst air quality in 2023, 13 are located in this region, representing around 30% of the total. Pollutants such as suspended particles (PM<sub>10</sub> and PM<sub>2.5</sub>), black carbon and carbon monoxide, despite originating in rural areas, spread over great distances, reach urban centers, and add to industrial and transport pollution. This exacerbates air quality degradation and environmental and public health impacts.

Biodiversity is profoundly affected by the presence of atmospheric pollutants, as they compromise fundamental processes such as plant growth and photosynthesis, which are essential for maintaining balanced hydrological cycles. Furthermore, the contamination of soils and water bodies causes changes in nutrient cycles, damages aquatic ecosystems, and threatens the survival of several native species. This ecological imbalance has direct repercussions on human health. In urban centers and riverside and Indigenous communities, continuous exposure to fine particles (PM<sub>2.5</sub>) leads to an increase in respiratory diseases, such as asthma and bronchitis, as well as aggravates cardiovascular conditions, such as hypertension and strokes. These effects are intensified during drought, resulting in a significant increase in hospital admissions, with children and the elderly being the most vulnerable groups.

## 04

IQAir. World Air Quality Report, 2023.  
**Available at:** <[https://www.iqair.com/dl/2023\\_World\\_Air\\_Quality\\_Report.pdf](https://www.iqair.com/dl/2023_World_Air_Quality_Report.pdf)>  
**Accessed on:** October 3, 2024

In 2019, the World Health Organization (WHO) highlighted air pollution and climate change as the top priority among ten healthcare emergencies that would affect one billion people globally.<sup>5</sup> The Global Burden of Disease report<sup>6</sup> found that particulate matter air pollution was the single biggest risk factor for the global burden of disease in 2021,<sup>7</sup> contributing to 8% of total DALYs (Disability Adjusted Life Years), a metric that quantifies the severity of diseases and equates it to the number of years lost to premature mortality and lived with disability.

Air pollution has proven to be a growing problem, with 8.1 million deaths attributed to air pollution in 2021, a number higher even than the number of deaths caused by smoking. More than 95% of the world's population is exposed to harmful levels of air pollution. Inhaling particulate matter impacts health in several ways and affects all systems of the body. Developing fetuses, for instance, suffer the consequences of their mothers' exposure to pollution.

Therefore, the impacts of air pollution in the Amazon go beyond environmental destruction; they directly affect the health of local populations and the social and environmental balance. The concept of "One Health" is

applicable here to recognize that human, animal, and environmental health are intrinsically linked. An integrated approach that considers these connections is key to protecting Amazon and its communities.

05

World Health Organization [WHO]. Ten threats to global health in 2019.

Available at: <<https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019>>

Accessed on: October 3, 2024

06

Brauer, Michael et al. Global burden and strength of evidence for 88 risk factors in 204 countries and 811 subnational locations, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. *The Lancet*, v. 403, n. 10440, 2024.

07

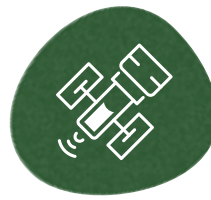
Considering all risk factors, including metabolic, environmental, and behavioral.

# Monitoring technologies



## STANDARD EQUIPMENT

They are considered the main reference in monitoring air quality. Also known as reference equipment or equivalent, these devices use robust and accurate techniques to measure specific pollutants. Generally installed in locations with controlled conditions, such as laboratories or containers, this equipment ensures precise and reliable measurement of atmospheric pollutants and is widely used in fixed monitoring stations. Each type of standard equipment is designed to detect and quantify a specific pollutant using techniques that may vary depending on the type of pollutant, such as fine particles ( $PM_{2.5}$ ), gases, or volatile compounds.



## SATELLITE MONITORING

It is a remote sensing technique that allows the collection of atmospheric data on a large scale. Remote sensing uses instruments on board satellites to measure pollutants at different altitudes and indirectly detect particles and molecules suspended in the atmosphere, thus providing a global and detailed view of the distribution of pollutants in the atmosphere. This technology is especially useful for monitoring remote and difficult-to-access regions, such as large areas of the Legal Amazon, where physical access may be limited. Satellite monitoring is a fundamental tool for observing the dispersion of pollutants, identifying emission sources, and analyzing atmospheric conditions in real time.

Existing air quality monitoring technologies include a variety of instruments and techniques, as well as air quality models that help integrate and interpret these data. Among these technologies, the most notable are standard equipment, satellite monitoring, low-cost equipment, and air quality modeling, recently reinforced by artificial intelligence.



## **LOW-COST EQUIPMENT**

These are a more affordable alternative to reference stations. Although they do not offer the same accuracy as standard equipment, they have become increasingly popular due to their reduced cost and ability to provide real-time data. These devices are smaller and more portable, thus allowing for greater monitoring coverage in areas that do not have infrastructure for reference stations. Low-cost equipment is widely used to measure parameters such as particulate matter and gases, and its implementation has grown in urban areas and regions with fewer resources.



## **AIR QUALITY MODELING**

Although it is not a direct monitoring technology, it plays a key role in integrating and interpreting data obtained by other technologies. Air modeling uses numerical and statistical data to create simulations that help predict and diagnose air quality in different areas. This tool allows spatially combining data collected by standard sensors, satellites, and low-cost equipment, providing a broader and more complete view of the air quality situation. Furthermore, modeling is essential for forecasts and developing strategies to mitigate and control air pollution.

# Air quality monitoring in the Legal Amazon

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Monitoring pollutant levels and atmospheric variables, such as temperature and humidity, is crucial for identifying environmental problems and evaluating the effectiveness of control measures. This continuous monitoring allows the adaptation of pollution mitigation strategies and provides support for the development of public policies aimed at human health and environmental preservation. Furthermore, the data collected contribute to the formation of historical series essential for scientific research and understanding long-term air pollution patterns. This information strengthens regional research, allowing the identification of the main sources of pollution, climate change and their specific impacts in the Legal Amazon. These studies are important for developing solutions adapted to the particularities of the region, considering the complex climatic and environmental interactions that characterize it.

However, currently, around

80% of the 250 automatic stations (standard equipment) are concentrated in the Southeast of Brazil, while this form of monitoring in the Legal Amazon only occurs in Maranhão (7 stations) and Pará (3 stations),<sup>8,9</sup> highlighting the great regional and spatial inequality in the coverage of these stations in different parts of the country. These two states are monitored by private reference equipment operated on behalf of environmental agencies, with information made available in the 2023 Annual Air Quality Monitoring Report and by MonitorAr, both from the Ministry of the Environment and Climate Change. Finally, the lack of stations limits the ability of public managers to respond to pollution crises.

In this context, the implementation and expansion of air quality monitoring networks in the region is essential. Still, it faces

## 08

Ministry of Environment and Climate Change. Relatório Anual de Acompanhamento de Qualidade do Ar 2023 (2023 Annual Air Quality Monitoring Report).

**Available at:** <<https://www.gov.br/mma/pt-br/assuntos/qualidade-ambiental-e-meio-ambiente-urbano/qualidade-do-ar/relatorio-anual-2023>>

**Accessed on:** October 3, 2024

## 09

Ministry of Environment and Climate Change. MonitorAr.

**Available at:** <<https://monitorar.mma.gov.br/painel>>


**Accessed on:** October 3, 2024

significant challenges, the biggest of which are related to the scarcity of human and material resources, limited infrastructure, and the vast territorial extension. Faced with these limitations and challenges, low-cost sensors emerge as a viable solution for monitoring in remote areas, enabling broader coverage. Below, we highlight this technology's main benefits and limitations as a resource for expanding Amazon's monitoring network.

## What are low-cost sensors?

They are compact, low-complexity and economically more accessible devices that monitor atmospheric pollutants and environmental variables, such as temperature and humidity, in real-time, and this is one of their most significant benefits. These sensors continuously monitor temperature, humidity, and suspended particles, such as PM<sub>2,5</sub>, and record data every 90 seconds, thus generating over 1,000 daily records. This data can be immediately made available online, allowing an instant air quality assessment in different locations. This enables the rapid identification of pollution peaks, such as those generated by fires.

Another critical point is the sensors' spatial coverage. Due to its more affordable cost and easy installation, creating denser and



more comprehensive monitoring networks is possible, especially in remote and difficult-to-access areas, where standard stations are unfeasible. These devices cost around 0.2% of the standard cost, making them financially viable for large-scale implementation. In addition to being cheaper, they require less maintenance and have reduced operating costs, requiring only electricity and internet access to function correctly. This allows monitoring networks to be created collaboratively, involving the local community throughout the process, from installation to data interpretation.

In addition to its low cost, this type of sensor is easy to install and maintain. It is quick and easy installation allows anyone to set up a low-cost sensor, as long as they have a power outlet and a Wi-Fi connection. This facilitates the creation of collaborative monitoring networks, allowing schools, universities, community institutions and even individuals to actively participate in collecting and analyzing air quality data. Online platforms allow this data

to be accessed from anywhere, thus democratizing access to information and increasing public awareness of the health risks associated with air pollution.

Finally, due to these real-time air quality monitoring characteristics and the possibility of expanding spatial coverage, low-cost sensors can be valuable aids in the early detection of fires in the Amazon. Because these devices record changes in air pollutant concentrations every 90 seconds, they can quickly identify pollution spikes associated with fire outbreaks. This continuous, real-time monitoring is beneficial in regions where fires spread quickly. It allows authorities to respond more readily and efficiently to combat fire outbreaks, especially in the Amazon, where it spreads closer to the ground and is harder to detect by satellite. The ability to detect these changes instantly, combined with the possibility of covering vast remote areas, makes these sensors a vital tool in mitigating the impacts of fires on the environment and public health.

# Logistical challenges and the need for integrated technologies

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## **Territorial coverage**

The vast territory of the Legal Amazon and the fact that it is hard to reach make air monitoring a logistical challenge. States such as Amazonas, Amapá, Roraima, and Acre have limited infrastructure, a precarious road network, and rivers as the main transport routes. This makes it difficult to install and maintain equipment. Furthermore, the preservation of large forest areas increases access difficulties, worsening the cost and logistics of implementing sensors. Given this scenario and the specificities of the territory, the design of the distribution of the different types of equipment becomes relevant for efficient coverage of air monitoring in the region. In remote areas, the lack of basic infrastructure, such as electricity and internet, makes operating autonomous sensors in real time unfeasible. In

these regions, passive sampling or manual data collection may be an alternative, but it compromises the frequency of measurements and the capacity for continuous monitoring. Another solution is using satellite internet technologies and solar energy.

## **Cost of installation, maintenance, and data reliability**

The high cost of installing and maintaining standard sensors, which require skilled labor and regular calibration, is one of the biggest obstacles to expanding a comprehensive monitoring network in the Amazon. Low-cost sensors are easier to install and operate, thus significantly reducing operating costs. However, there are limitations to these sensors, such as lower precision, greater sensitivity

to climate variations and reduced durability, and they require periodic validations with higher precision sensors to ensure the reliability of the data collected.

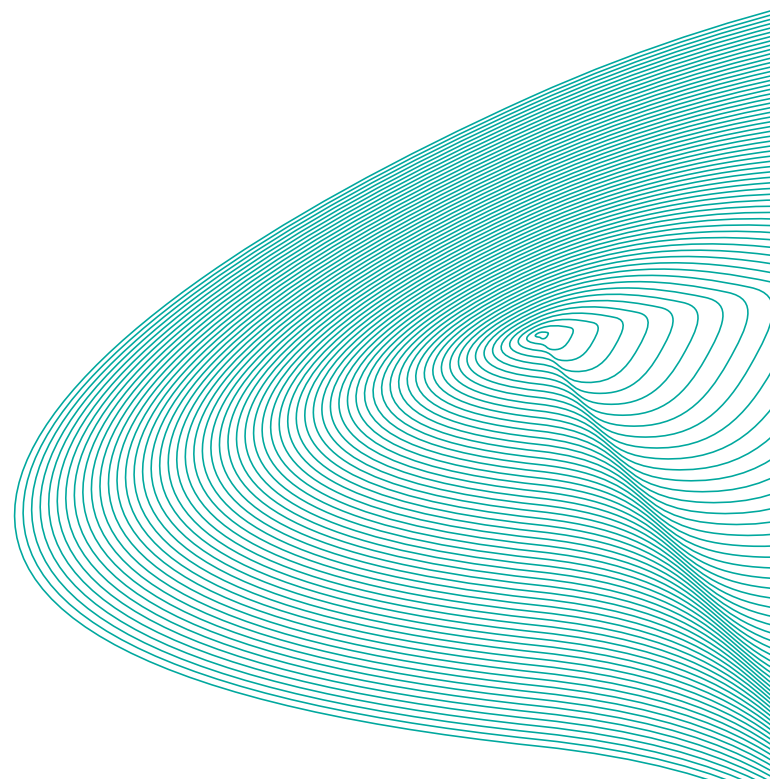
## **Data access**

The challenge is ensuring that data is accessible to the public openly and transparently. Creating a public database requires a robust and secure platform to process and store large volumes of information and experts to perform integrated analyses that consider variability in measurements and impacts on public health. Integrating this data with other monitoring platforms is essential for enabling informed and effective decisions.

## **Technical capacity and infrastructure**

Although satellite monitoring and models are useful to overcome spatial coverage challenges, these technologies require great technical capacity and infrastructure to process the data and present greater uncertainty compared to ground-based sensors. So while these tools are valuable, they should not be used alone but rather in conjunction with others to ensure more reliable measurements.

In conclusion, implementing an air quality monitoring network in the Legal Amazon depends on a strategic combination of technologies that can overcome the region's logistical and financial barriers. Low-cost sensors offer a viable solution to expand coverage, especially in remote areas, but they need to be integrated with reference systems and continuous validation to ensure data reliability. Furthermore, public access to this data through robust and transparent platforms is essential to promote awareness and guide effective public policies. While satellite monitoring and predictive models complement these tools, they cannot replace a solid technical infrastructure and the integration of different technologies for a more effective response to the challenges of air pollution and environmental preservation.





# The recent National Air Quality Act

Public air quality policy is crucial to guaranteeing fundamental rights provided for in the Federal Constitution, given the vital role of the atmosphere in ecological balance and quality of life. Continuous monitoring is especially important as it allows one to measure air pollutant concentrations, generate accurate data on current air conditions and build robust historical data. This information enables decision-makers to plan and implement effective public policies to ensure good air quality, improve information for citizens and protect the health of the population and the environment.

The absence of a unified legal framework made efficient coordination between states and municipalities difficult, resulting in failures in both inspection and monitoring of air pollution. Even with environmental standards in force, these instruments were insufficient to address the

complexity of the challenges posed by air pollution, especially in the regions most affected by fires and deforestation, where environmental degradation is accelerated and the impacts on public health are serious.

The implementation of air quality monitoring in the national territory was determined by the National Air Quality Program, Pronar (Conama Resolution 05/1989), which made the States responsible for monitoring, but this did not occur in the Legal Amazon.<sup>10</sup>

10

BRAZIL. Brazilian Institute of the Environment and Renewable Natural Resources (Ibama). Conama Resolution No. 005, of June 15, 1989.

Available at: <<https://www.ibama.gov.br/sophia/cnia/legislacao/MMA/RE0005-150689>. PDF>

Accessed on: October 3, 2024



The recent enactment of Law No. 14.850, of May 2, 2024, which establishes the new National Air Quality Policy,<sup>11</sup> represents a significant milestone and should help change the current situation, as it establishes the creation of the National Air Quality Monitoring Network. This step is essential to standardize nationwide monitoring and enable a more coordinated approach based on reliable data. However, the full implementation of this law still faces major challenges, such as a lack of resources, adequate infrastructure and technical training in many states and municipalities.

Despite the advances brought about by Law No. 14850, much must be done to ensure its effective implementation. Strengthening monitoring infrastructure and aligning air quality policies with air quality and public health monitoring systems are key to ensuring that this policy fully meets the population's and the environment's needs. Without such coordinated measures, the impact of policies will be limited, especially in regions suffering from severe pollution and events such as wildfires. Furthermore, cross-referencing pollution data with information from healthcare systems, such as hospitalization rates for respiratory problems, would deepen understanding of the impacts. This would enable the creation of more effective and preventive public policies, protecting the population more fully. Integration between the Unified Health System (SUS) and environmental monitoring would strengthen prevention and response strategies, ensuring that public health interventions are faster and more efficient, especially in situations of significant deterioration in air quality.

11

BRAZIL. Law No. 14850 of May 2, 2024. It establishes the National Air Quality Policy.

**Available at:** <<https://legis.senado.leg.br/norma/38430678>>

**Accessed on:** October 3, 2024

# International success stories

## ULAN BATOR, MONGÓLIA<sup>12</sup>

This city is one of the most polluted in the world, mainly because it uses coal as the primary heating source in Mongolian “gers”—traditional housing where a large part of the population lives. Heavy reliance on coal poses serious health risks, including increased chances of cardiovascular and respiratory diseases. To address the lack of air quality monitoring in such remote locations, a team of researchers has developed a low-cost sensor capable of transmitting atmospheric data in real time and designed to work in challenging conditions. These devices offer humanitarian organizations a way to measure the effects of their actions to reduce pollution in these communities. The project is significant due to its technical innovation and the lessons learned from deploying these sensors in such unique environments.



12

L. Alcantara, J. Miera, B. Ariun-Erdene, C. - C. Teng, P. Lundrigan. The Hitchhiker's Guide to Successful Remote Sensing Deployments in Mongolia. 2020 Intermountain Engineering, Technology and Computing (JETC), Orem, UT, USA, 2020, pp. 1-6, doi: 10.1109/IETC47856.2020.9249214.

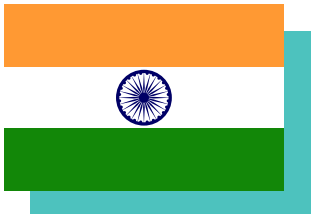
## DAR ES SALAAM, TANZÂNIA<sup>13</sup>

As a rapidly growing city, Dar es Salaam faces significant challenges in terms of air pollution due to increasing urbanization and dependence on fossil fuels. The city has been using low-cost sensors to expand its air quality monitoring network. These devices offer an affordable alternative to expensive reference monitors, allowing the city to cover a larger area and get a more detailed view of pollution patterns. Sensors help measure pollutants such as particulate matter and gases emitted mainly by vehicles.



13

C40 Cities Climate Leadership Group. Sensing Change: How cities are using new sensing technologies to achieve air quality goals. C40 Knowledge Hub.  
**Available at:** <<https://www.c40knowledgehub.org/s/article/Sensing-Change-How-cities-are-using-new-sensing-technologies-to-achieve-air-quality-goals>>  
**Accessed on:** October 3, 2024



## BANGALORE, ÍNDIA<sup>14</sup>

The air quality monitoring campaign in Bangalore used low-cost sensors and mobile monitoring to generate high-resolution pollution maps. The research aimed to fill the gaps in conventional monitoring by combining stationary sensors and mobile unit networks to measure black carbon and ultrafine particles. The main findings were the identification of high levels of pollution on major roads compared to residential areas, as well as a seasonal increase in pollution during the winter. The initiative showed that monitoring with low-cost sensors can provide valuable spatial data to guide policy decisions on reducing traffic-related emissions. Policy recommendations included expanding monitoring to rural areas and addressing traffic emissions in high-pollution zones of Bangalore.

14

CSTEP. Mapping air pollution in Bengaluru using low-cost sensors and mobile monitoring data, March 23, 2023.  
**Available at:** <<https://estep.in/publications-details.php?id=2321>>  
**Accessed on:** October 3, 2024

# Ongoing initiatives projects in the Amazon

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**In all states in the region, initiatives aim to expand monitoring using low-cost sensors. Four success stories from partners of the Respira Amazônia Coalition stand out here.**

## **Acre monitoring network**

The installation of a network of low-cost sensors in Acre emerged to address serious air quality problems, exacerbated by the lack of official local and regional monitoring. Between 2019 and 2021, the increase in fires and deforestation intensified the urgency for innovative solutions. With support from the Public Prosecution Office of Acre and the Federal University of Acre, an air quality monitoring network was created using low-cost sensors in 22 municipalities, financed by resources from criminal transactions. This project, which illustrates the articulation between civil society, researchers, and public prosecutors, emerged to fill the gap left by the absence of public policies aimed at environmental monitoring.

Although innovative, the project faces ongoing challenges, mainly related to governance and the lack of resources to maintain and operate the system, which is largely driven by local volunteers. The sensors used are more affordable than standard stations, allowing for broader dissemination of air quality data. However, the accuracy of these sensors depends on weather conditions and particles monitored ( $PM_{1.0}$ ,  $PM_{2.5}$ ,  $PM_{10}$ ), representing an additional challenge in terms of calibration and maintenance.

The data generated is accessible on platforms such as Acre BioClima, providing real-time information on air quality in different regions. However, the absence of a structured historical series and the English interface limit the local population's access to this information. Even so, the project has promoted public awareness about the impacts of fires and mobilized government agencies to tackle the problem.

With plans to expand monitoring to other areas of the Legal Amazon, the project has proven to be effective. Furthermore, it was recognized by awards such as INNOVARE, which highlights innovations in legal practices and public policies, and served as the basis for creating the Respira Amazônia Coalition, reinforcing its importance in the context of environmental protection and public health in the region.

## **SELVA Platform**

The SELVA (Electronic Environmental Surveillance System) Platform is an environmental education tool of the “EducAir - Environmental Education in Air Quality” Project. Professors and students from the Postgraduate Program in Climate and Environment (PPG-CLIAMB - INPA/UEA), at the School of Technology (EST) of the State



University of Amazonas (UEA), began developing the SELVA Platform in 2021. Their first financial support came from a partnership between the Cuomo Foundation (Monaco, France), the UEA and the Fundação Universitas de Estudos Amazônicos (FUEA), aimed at bringing to light the problems of air pollution in the Brazilian Amazon, with a focus on educating and alerting students in public schools in Amazonas and their families about the importance of conserving the forest and good air quality, protecting public health and preventing climate change.

The SELVA Platform integrates different environmental data, including: monitoring of atmospheric pollution (fine particulate matter) using low-cost air quality sensors, data on the concentration of fine particulate matter in the atmosphere



estimated by numerical air quality models (CAMS – Copernicus Atmosphere Monitoring Service), data on fire outbreaks identified by environmental satellites, data on precipitation estimated by meteorological radars, and other environmental data. The project partnered with the State Department for the Environment, the Public Prosecution Office of the State of Amazonas, the Civil Defense of the State of Amazonas and the State Department for Education and School Sports of Amazonas to install low-cost air quality sensors in all municipalities of the State of Amazonas.

In this context, the project's goal is for the SELVA monitoring platform to become the main source of

rapid information for the general population, institutions, and governments in the areas most affected by fires in the Brazilian Amazon. It aims to contribute to improving people's quality of life, day after day, by providing information to help with decision-making and fundamental changes in society's actions. SELVA seeks to continue growing, increase its team and structure, and develop digital equipment and technologies to provide the best monitoring service and solutions to environmental problems in cities and remote areas of the Amazon. Initiatives like this highlight the urgency of implementing air pollution prevention and management measures in the Amazon, including the development of effective alerts for large-scale events and improved forest fire management strategies to mitigate their impact on air quality in cities in the region.

## **Project to expand the monitoring network in the Legal Amazon – IPAM**

Motivated by the Acre Monitoring Network initiative, between 2021 and 2024, the air quality monitoring network was expanded to the entire Legal Amazon with the installation of 60 low-cost sensors across the nine states of the Legal Amazon by the Amazon Environmental Research Institute (IPAM) and the Woodwell Climate Research Center. The network expansion aimed to assess air quality in cities and areas of different land categories (Conservation Units, Indigenous Territories, and Agricultural Territories). The results show that, regardless of the land category, during the dry season and with the increase in fires, air quality reaches levels of particulate matter ( $PM_{2.5}$ ) well above those recommended by the World Health Organization and the Ministry of Environment and Climate Change, thus demonstrating the importance of expanding the monitoring network not only in cities.

### **Redt Amazonas**

In November 2023, the Government of the State of Amazonas and the Embassy of South Korea signed a technical cooperation agreement to create the Biodiversity Protection and Conservation Network through Technologies (Redt/AM). The initiative aims to improve efforts to combat deforestation and illegal burning in Amazonas and extend air quality monitoring to all 62 municipalities in the state. As part of the project, the government acquired 100 low-cost sensors to monitor the concentration of particulate matter throughout the region.

The sensors will be installed with the support of the State Civil Defense throughout 2024 in all municipalities. This air quality data will be integrated into the SELVA platform as installations are completed, thus strengthening response capacity and environmental management in Amazonas. Redt/AM reflects the collaborative effort between Brazil and South Korea to use cutting-edge technology in environmental monitoring and protection.

# PROBLEM SOLUTION

## TERRITORY

The vast expanse of the Amazon territory makes comprehensive air quality monitoring difficult.



## EMISSION SOURCES

Burning and forest fires are the region's primary sources of atmospheric pollutant emissions.



## LAND CHANGE AND USE

The expansion of the agricultural frontier has intensified environmental degradation and increased emissions.



## ABSENCE OF INFORMATION

There is a significant gap in official data on air quality in the Amazon.



## DISSEMINATION OF INFORMATION

The lack of adequate communication prevents the population from understanding the seriousness of the problem and taking preventive health measures.



## LOW-COST EQUIPMENT

Low-cost sensors effectively mitigate an “information blackout” by providing relevant data on air quality.



## STRATEGIC DISTRIBUTION

Strategic installation of this equipment throughout the Amazon region to ensure data collection and real-time monitoring.



## DATA COMPLEMENTARITY

Data from low-cost equipment supplements other monitoring methods by providing detailed surface-level analysis.



## EFFICIENT DISSEMINATION OF INFORMATION

Providing real-time information allows the population to understand the air quality situation and take appropriate preventive actions.

# Recommendations

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**1**

## Investment

Investing in low-cost sensors and reference stations is key to improving monitoring coverage and quality. Robust infrastructure, with qualified data analysis and dissemination teams, is also necessary. Furthermore, encouraging domestic production of sensors can reduce costs and expand the monitoring network. Investment in technological infrastructure, such as servers to store large volumes of data, is equally important.

**2**

## Integration

Incorporating low-cost sensors into the monitoring network can help automatic stations and satellites, especially in remote areas. The national air quality policy must be integrated with fire monitoring, and collaboration between the public and private sectors is crucial to ensure the expansion and efficiency of monitoring networks.

**3**

## Communication

Making air quality data accessible to the public is vital to raising awareness. Implementing alert mechanisms about health risks through applications and social networks will allow a rapid and preventive response. It is also recommended that public health communication systems be implemented to help mitigate the adverse effects of smoke, especially for at-risk groups and professionals involved in firefighting.

**4**

## Training

Training public managers to deal with air quality monitoring, from installation to data interpretation, is essential to ensure the effectiveness of actions.

## 5 Environmental Education and Mobilization

The active participation of various actors, such as environmental agencies, universities, NGOs, and civil society, is essential to strengthen monitoring and promote sustainable solutions. This collaborative engagement contributes to the implementation of effective and integrated actions. Furthermore, including topics on air quality in schools is an effective strategy to raise awareness among new generations and encourage engagement with the environmental cause from an early age, creating a culture of preservation and responsibility.

## 6 Research

Investing in scientific research that assesses the impacts of pollution and improves the quality of low-cost sensors is essential to support public policies and improve predictive models.



## 7 Infrastructure and strategy

Investing in basic infrastructure, such as internet and electricity, is essential to ensure monitoring in remote areas, especially with the use of alternative technologies such as solar panels. Furthermore, it is vital to create methods for local data storage in regions without connectivity, thus avoiding the loss of important information. At the same time, the implementation of a strategic territorial plan for the distribution of sensors must prioritize states with low coverage. The expansion of monitoring to Conservation Units, Traditional Territories, Indigenous Lands, farms, and strategic areas is equally fundamental to ensure comprehensive and effective coverage.

# Considerations

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The Legal Amazon's vast expanse and geographic complexity present enormous challenges for air quality monitoring. However, given the geopolitical and environmental importance of the area and the constant threats to air quality in the region, primarily due to fires, it is essential that this monitoring be carried out robustly and comprehensively. Integrating new technologies is the most promising solution to these obstacles. Standard monitoring equipment, known for its high accuracy and robustness, is essential to ensure data quality. However, the high costs and logistical difficulties of installing and maintaining these devices in such a large, difficult-to-access region limit their implementation. In this context, low-cost sensors appear as a strategic alternative, as they are more accessible and easier to install, enabling the expansion of the monitoring network to remote areas.

Low-cost sensors still face challenges such as lower accuracy and reduced service life compared to reference equipment. Therefore, it is essential to calibrate and validate them regularly against standard sensors to ensure data reliability. Furthermore, it is necessary to continue investing in research and innovations that improve these devices, ensuring that they operate with greater precision, even in extreme weather conditions, such as those found in the Amazon. Overcoming these technological challenges will enable denser and more accurate monitoring coverage, especially in locations where installing traditional equipment is not feasible.





Collaboration between different actors is equally fundamental in this process. Researchers, public managers, technicians, and local communities must work together to ensure the successful implementation of monitoring networks. Researchers' expertise is essential for effective data analysis and interpretation, while public managers must be able to use this information to formulate policies that combat air pollution and protect vulnerable populations. Engaging local communities, particularly in remote areas, is essential to ensure the dissemination of information and social mobilization around air quality.

Finally, overcoming the challenges related to air quality monitoring in the Legal Amazon depends on creating an adequate infrastructure, which includes energy and internet in remote areas, in addition to continuous investment in research to improve monitoring technologies. Collaboration between the public and private sectors is also key. Only with this synergy will it be possible to guarantee the effectiveness of public policies in reducing atmospheric pollution and protecting Amazonian ecosystems. A collective effort, associated with the strategic use of advanced technologies, will be key to facing the complex environmental challenges of the Legal Amazon, preserving the health of local populations and one of the most important natural heritages on the planet.

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