Microsoft

AI for Earth grantee profile

SOS Mata Atlântica

Protecting the rivers of Brazil's Atlantic Forest

Abstract

Brazil is rich in fresh water sources, yet millions of its people lack access to clean water. Within the Atlantic Forest region along Brazil's southeast Atlantic coast, even such major rivers as the Rio Tietê, which flows through the São Paulo metropolitan area, are unprotected from contamination by garbage and other pollutants. That leads to waterborne diseases causing millions of preventable hospitalizations and deaths. The SOS Mata Atlântica Foundation has been monitoring the water quality of the rivers in the Atlantic Forest for years, working to call attention to this plight. Through a grant from Microsoft AI for Earth and the development work of EloGroup, the Foundation now has a machine learning model that can predict water quality out to five years in advance based on historical data, and a dashboard on its website to clearly present the findings. With these tools, SOS Mata Atlântica is better positioned to advocate for changes in the laws so that the rivers will be protected and safe fresh water will be available to everyone.

Protecting the rivers of Brazil's Atlantic Forest

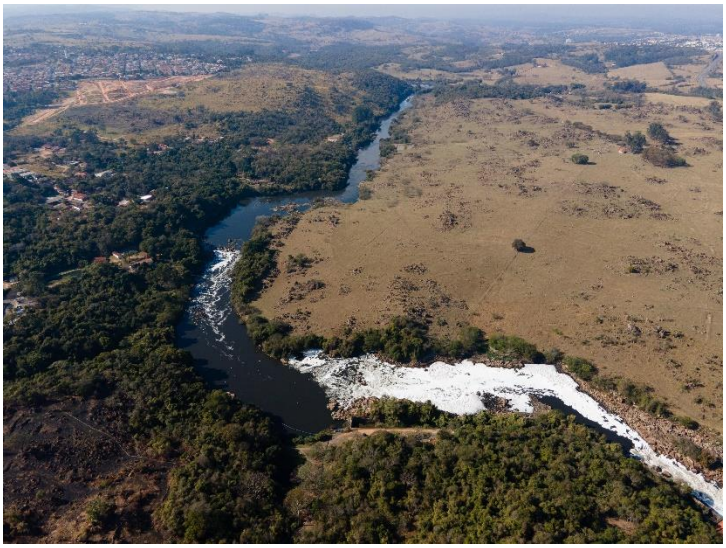
The Atlantic Forest—Mata Atlântica in Portuguese, the national language of Brazil—runs the length of Brazil's southeast coast and in its southern end reaches inland as far as Paraguay and Argentina. Stretching across 17 of Brazil's states, the forest encompasses the homes of 72 percent of Brazil's population, including over 30 million people just in the São Paulo metropolitan area. The forest region supports a very high biodiversity, with many of its species, both plant and animal, being found nowhere else in the world, and new species still being discovered. Additionally, the forest plays a vital role in the ecosystem, helping to regulate the climate, refresh the water supply, and ensure soil fertility. For the people of Brazil, the forest is a source of food and medicines, as well as a home.

However, the current Atlantic Forest represents only 12.4 percent of its original extent, with much of the area having been deforested through human activity. Clearing the forest for agriculture, pasture, logging, and expansion of urban areas poses a grave threat not only to the forest and the biodiversity it supports but also to the benefits it provides to humans as well. For this reason, the SOS Mata Atlântica Foundation was created in 1986 to protect the Atlantic Forest through monitoring and research, public engagement, and legislation. The

Foundation's goals include forest restoration, increased public appreciation for parks and reserves, clean water, ocean preservation, and fighting against climate change.

Calling attention to water pollution

Ecosystems are interdependent in many ways. SOS Mata Atlântica has understood all along that protecting the Atlantic Forest means more than just preserving trees. For instance, the Atlantic Forest helps to protect water sources and ensure clean water, but when the forest is cleared those sources are threatened. Likewise, when humans pollute the water sources, the forest and all the life it supports—including humans—are threatened.



Tietê River, Brazil.

Photo courtesy of SOS Mata Atlântica.

Although Brazil has as much as 13 percent of the world's available fresh water, 35 million of its people lack access to clean water. Currently Brazilian law for water quality standards includes a category called "class 4" which allows unlimited concentrations of pollutants, and that makes many sources of water unsafe for use. Only 40 percent of the nation's sewage is treated, which among other effects means that waterborne diseases cause more than 70 percent of the hospitalizations. Afra Balazina, Director of Communication and Marketing at SOS Mata Atlântica, says, "They say sanitation is inside—we don't see it so nobody votes for it, so it's not important for mayors and other officials, so they don't put an effort to it. If we as society and NGOs and the community don't push it, they don't do it."

> "Currently you can put everything you want in the Tietê River because of the regulations. We want to change the legislation so it's not possible anymore to do that."—Afra Balazina, SOS Mata Atlântica

Over 30 years ago, SOS Mata Atlântica began its campaign for the depollution of the Tietê River. The largest river in the state of São Paulo, the Tietê originates in Salesópolis, a small city in the Serra do Mar ranges near the coast which form a barrier to the Atlantic Ocean. The Tietê flows inland first, west and south to the Paraná River, passing through the city of São Paulo along its way. Although it is not navigable from the city, the river has been an important resource for São Paulo, providing hydroelectric power and at one time serving as a source of fresh water, fishing, and leisure activities. However, during the 20th century, the river became heavily polluted from industrial and wastewater discharges, and as recently as 2010 was considered the most polluted

in Brazil. “Currently you can put everything you want in the Tietê River because of the regulations,” says Balazina. “We want to change the legislation so it’s not possible anymore to do that.” To help advocate for cleaning and protecting the Tietê River, SOS Mata Atlântica began a volunteer program of monitoring the water quality of the river.

The Tietê was the first river monitored since it goes through such a major city, but about five years ago SOS Mata Atlântica expanded the program, which it calls Observando os Rios (“Observing the Rivers”). “We started monitoring other rivers because the Atlantic Forest of course is in 17 states in Brazil, so we wanted to go further and monitor rivers in all the states of Mata Atlântica,” explains Balazina. Today, the Foundation works with over 3,000 volunteers to monitor 230 rivers in nine watersheds across the Atlantic Forest region.

Monitoring the rivers of the Atlantic Forest

“There are many kinds of volunteer groups with us,” says Balazina. “We have teachers with their classes in school, so we have a school near one river for instance, every month the teacher takes different students to see the river, collect the water, and put the data on the website.” Community groups, Scout troops, and universities also participate. Balazina says the university groups have a more reciprocal relationship. “They get the data for us, so they help us, but we also help them to do other research. There are biologists and people who study water quality, so they also use this material in their research.”

Observando os Rios water quality testing kit.

Photo courtesy of SOS Mata Atlântica.

For years the monitoring program has followed a fairly basic procedure. Volunteers collect water samples at specific locations along the rivers monthly, checking a variety of quality factors ranging from color and sediments to chemical parameters such as nitrate levels and bioindicators such as the presence of fish. The volunteers write down their findings in a notebook and then later submit the data by email to SOS Mata Atlântica. The Foundation also sends out its own teams on special expeditions when unusual events occur, such as an accident at a mine causing a surge of pollutants entering a river; these teams have access to advanced equipment allowing them to do more in-depth testing.

Consistency is important—taking samples from the same locations, month after month, year after year, helps to build up a historical view of the river conditions and inform a better understanding of what needs to be done. So the Foundation does work to support and encourage the volunteers, and actively recruits new ones as needed. The COVID-19 pandemic has been a challenging time for the volunteer program, as restrictions vary

among the states. “We were very rigorous about that, because safety is in the first place,” says Balazina, “and then we changed as well the way to go to the river, just two per group with a lot of care and [protective] equipment.”

> “We thought it was very important if we could show how the situation is going to be if we don’t have public policies for sanitation and so on, if we don’t treat what is going to happen. We started to talk about technology that could show us more than we have with this data of the water quality.”—Afra Balazina

SOS Mata Atlântica has been collating the submitted data in Microsoft Excel spreadsheets to run some analysis on the changes in water quality over time. Once a year, it would publish a study of the situation across all the rivers. However, in 2020 the Foundation began thinking about taking a forward view. “SOS Mata Atlântica works on environmental issues in water, forest, and so on, but we don’t work with health issues,” explains Balazina. “We thought it was very important if we could show how the situation is going to be if we don’t have public policies for sanitation and so on, if we don’t treat what is going to happen. We started to talk about technology that could show us more than we have with this data of the water quality.” If the Foundation could use its accumulated data to forecast the water quality a few years into the future, it could use that prediction to encourage better policies for sanitation and protection of the rivers. To develop its vision, the Foundation started talking to Microsoft.

Learning to predict water quality

“Olavo [Garrido], our Director of Finance and Business, was talking to Microsoft about doing a project together,” says Balazina. “We wanted to get a better place to put this data so it would be easy not only for our volunteers but also to our public.” At the time, the water quality data was shared in various ways, from journalists finding it on the website to the Foundation submitting it to TV news or sharing on its social media. SOS Mata Atlântica wanted everyone in the general public to be able to find, read, and understand the situation with the rivers, and envisioned a central dashboard on its website.

Testing the water of the Tietê River, Brazil.

Photo courtesy of SOS Mata Atlântica.

Testing the water of the Tietê River, Brazil.
Photo courtesy of SOS Mata Atlântica.

"Microsoft introduced us to Rafael and his team to work on the project," says Balazina. "It really begins with Microsoft and SOS Mata Atlântica talking together, working together, and then to put this into practice, they called up the partner." Rafael Cabral is senior consultant at EloGroup, a Microsoft partner that integrates technology, analytics, and management through its business transformation platform. His team of data scientists and engineers developed the data analysis, machine learning model, and presentation tools for the project.

Additionally, the Foundation hoped to show how the pollution of the rivers was connected to public health. Balazina says, "It's important to show that sanitation and healthcare are very important and related with water quality. We have many diseases that come through water, so we have bad sanitation, we have many diseases and many deaths." To make that connection, SOS Mata Atlântica would need not only access to public healthcare data but also data analysis and modeling tools that could find the patterns and make predictions. SOS Mata Atlântica supplied its own data since 2000 on the water quality and also forest cover, while sanitation data since 2015 came from Brazil's National Sanitation Information System (SNIS), and data since 2010 on hospitalizations and deaths related to water-borne diseases came from DATASUS.

> "It really begins with Microsoft and SOS Mata Atlântica talking together, working together, and then to put this into practice, they called up the partner."—Afra Balazina

Cabral's team at EloGroup initially analyzed the data looking for correlations that might show how forest cover and sanitation affected the water quality and hence the health consequences. However, the results were inconclusive, due to a lack of sufficient data among the data sets. "Unfortunately, we don't think that all the health data are correct, in terms of we think it's not all there," explains Balazina. "Probably there are more deaths and more problems than is there [in the data], because we know it's very different situations from one state to another." In a related fashion, the data for some municipalities might show a *decrease* in water quality

shortly after investments in sanitation, rather than increase, because not enough time had passed for the effects of the improvements to show in the data.

Instead, the Foundation and EloGroup decided to build a machine learning model to predict water quality in the future based on existing trends. With the support of a Microsoft AI for Earth grant, Cabral's team built the solution with tools in Microsoft Azure cloud computing. Cabral explains the Azure architecture: "We use Azure Functions to collect this data, Azure Data Factory to orchestrate this data and the notebooks with the codes, Azure Blob Storage to store the data, and we use Azure Machine Learning. We transform the data with [Azure] Databricks, and store the final data in Azure SQL databases, and this data goes to the dashboard in web pages in SOS." The Elastic Net machine learning model was chosen as the best model for projecting the data trends out one year and five years. Through development and testing, the model achieved 87 percent accuracy on 12-month predictions given at least 24 months of observations, and over 96 percent accuracy on 60-month predictions given 120 months of observations.

Advocating for better water quality for all

With the years of data from the Observing the Rivers project now visible on the Foundation's website and a predictive model in place, SOS Mata Atlântica is better positioned to advocate for change. In particular, the Foundation has been preparing for national elections in Brazil in 2022, putting together materials for every candidate to show the importance of the water quality issue. Also, volunteers for the Foundation can use these materials for discussions in their local water councils, which have the authority to regulate the dumping of garbage and pollutants into the rivers. One goal is to end the use of the "class 4" designation, changing the laws so that the rivers can no longer be polluted freely. "It's all new, we didn't have this before," says Balazina. "It was a big improvement for us to have this data and to show it like that. Now we can try to show to people and to government that it's important to invest in sanitation and to put money on this in order to avoid many hospitalizations and deaths."

Resources

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SOS Mata Atlântica's home site: https://www.sosma.org.br/

Observing the Rivers project site: http://indicadores.observandoosrios.sosma.org.br/

Observing the Rivers dashboard: http://indicadores.observandoosrios.sosma.org.br/indicadores