University of Alberta

Analyzing real-time sensor data to understand climate and environmental change

Smart is...

Using powerful analytics to measure the health of forests in real time, spot warning signs indicating future natural disasters, and enable the best possible response by policymakers.

To better understand the impact of climate change on sensitive ecosystems, scientists at the University of Alberta deploy hundreds of sensors to measure variables such as temperature and humidity in the forests of Canada, Central and South America, and scrutinize the data collected using extremely powerful analytics software from IBM. The researchers gain real-time insight into changes in ecosystems, and can even spot warning signs which help predict trends of environmental degradation, enabling the best possible response by policymakers.

Based in Edmonton, the University of Alberta is one of the largest research-intensive educational institutions in Canada, with more than 39,000 students and around 15,000 staff.

Pioneering environmental research

The University's Centre for Earth Observation Sciences (CEOS) is running a multi-year research project to investigate the impact of climate change on boreal and tropical dry forests in a huge region of Canada and Latin America. In the case of Latin America, CEOS's work on tropical dry forests areas is conducted in some of the most remote and vulnerable ecosystems in the world; any changes could impact food security for the 900 million people living in the region.

Dr. Arturo Sanchez-Azofeifa, a professor and researcher at the University's Department of Earth and Atmospheric Sciences, explains: "We set out to monitor the effects of climate change on forests in these regions and investigate the effects of governmental policies on the environment – both on the whole and in specific areas. This research includes recognizing the advance signs of natural disasters such as droughts.

"When we first started out, we adopted a traditional approach to the research – sending scientists into the field to collect data over a certain period of time, recording the data in data loggers, and then returning home to analyze the results on spreadsheets. It took weeks of intense work over relatively small sets of data to generate insights, and we would be able to study only a few hectares of land without generating huge economic costs."

Business benefits

- Help predict environmental degradation trends, enabling policymakers to prepare in advance and protect affected populations.
- Reduce research time from months to minutes to unlock meaningful insights into changes in natural environments.
- Enable a small team to gain remarkably detailed insight into the health of ecosystems across many countries, rather than just a few hectares.
- Provide state-of-the-art research capabilities that help distinguish the University from rival institutions in the competition for funding.
- Raise the University's profile as its scientists present at top global climate change conferences.

He continues: "To truly understand the impact of climate change over a large area – and gain insight fast enough to actually help policymakers respond – the only option was to find a way to collect and analyze the data in real time. We had to look beyond conventional methods and adopt a revolutionary approach to research – then we turned to IBM to make that vision into a reality."

Game-changing analytic capabilities

The University began by deploying hundreds of sensors, which measure variables such as temperature, humidity, atmospheric pressure, carbon levels and ambient noise in the forests. The data from these sensors is transmitted back to the University, where it is ingested, analyzed and correlated by powerful IBM® InfoSphere® Streams software.

Dr. Sanchez-Azofeifa says, "IBM delivered the know-how and technology to turn our vision of analyzing data in motion into a reality. People talk about the Internet of Things, but that's really an urban-centric concept – we are developing the Internet of the Environment.

"The IBM engineers came to the University, helped us with advice on how to set up the computing infrastructure we needed to support ultra-fast analytics, and then provided training sessions to teach us how to harness the full power of the technology. We still work very closely with the IBM team, and have weekly conference calls with the consultants to catch up on the latest developments."

Smarter Education — Driving real-time insight into climate change

Instrumented

High-velocity data on variables such as temperature and humidity, captured by hundreds of sensors in forests across Canada, Central and South America, is transmitted to the University for analysis.

Interconnected

Streaming sensor data is analyzed and the results feed dashboards that correlate multiple climatic variables, enabling agencies to monitor the effectiveness of environmental policies in real time.

Intelligent

Real-time insight into forest conditions provides unprecedented intelligence around the potential impact of climate change, enabling better policy-making toward adaptation responses to climate change.

Solution components

Software

- IBM® InfoSphere® Streams

Services

- IBM Software Services for Information Management

"IBM analytics is the backbone of our groundbreaking research. I would not be able to do what we are doing today without the power of IBM InfoSphere Streams."

— Dr. Arturo Sanchez-Azofeifa, professor and researcher, Department of Earth and Atmospheric Sciences, University of Alberta

IBM InfoSphere Streams analyzes more than 10,000 data points per second from the 500 sensors spread throughout the forests. Each sensor captures readings of up to six variables, and data is captured as fast as 20 times per second for some variables. Across all 500 sensors, this adds up to hundreds of billions of data points per year.

Petr Musilek, a professor at the University's Department of Electrical and Computer Engineering, adds: "The sensors are densely packed and record data points frequently – this means that we get a much faster and deeper understanding of what is happening in the environment than we could ever obtain using satellite imagery alone."

Real-time insight into vulnerable ecosystems

Implementing the cutting-edge InfoSphere Streams solution has slashed the time taken to gain meaningful insights into changes in ecosystems from months to minutes, and enables a relatively small team at the University to study an enormous geographical area rather than just a few hectares.

"We are detecting, visualizing and even predicting subtle changes in the health of ecosystems in real time, and also using these insights to develop an in-depth understanding of patterns in climate change and how different environments respond to it," explains Dr. Sanchez-Azofeifa.

"We have our eyes on the field from Alberta. The insights we receive are so detailed that we can see the impact of a swarm of bugs eating leaves as sensors closer to the forest floor start to detect higher levels of light. We can also examine how storm damage changes the photosynthetic potential of tree foliage. This insight is a paradigm shift for science – thanks to IBM InfoSphere Streams, we can stop saying 'this happened' and start saying 'this is happening now.'"

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Predicting when and where disaster will strike

CEOS is gaining an unprecedented ability to identify the warning signs of natural disaster in advance (such as low humidity levels indicating drought), helping the researchers to understand when and where disaster is likely to strike.

"We can give governments warnings about environmental disasters 100 days before they happen – giving them time to inform local people and plan the most effective possible response," adds Dr. Sanchez-Azofeifa. "Ultimately, our research is helping to drive smarter and faster decision-making."

The University of Alberta researchers have also uncovered new insights into how forests in different regions respond differently to climate variations – this information enables governments and NGOs to adapt their operations to suit local areas, rather than using a 'one size fits all' approach.

Furthermore, these organizations can monitor the effectiveness of their environmental policies in real time, predict the likely effects of climate variations, and identify the best ways to tackle them. The University is currently working on improving data visualizations to help convey meaningful insights to decision-makers more clearly, supporting environmental stewardship.

Dr. Sanchez-Azofeifa continues: "As we refine our econometrics models to quantify the effects of changes, such as deforestation or fires, more accurately, we can make governments sit up and pay attention to our findings. For example, our preliminary results from Costa Rica suggest that the current effects of intense drought over tropical dry forest regions of the country could cost in the order of USD400M on carbon sequestration from forests on these regions. This would be in addition to multi-million dollar losses in the agricultural system. All CEOS data we collect is publicly available, so governments and Non Governmental Organizations can analyze and draw their own conclusions from it."

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— Dr. Arturo Sanchez-Azofeifa, professor and researcher, Department of Earth and Atmospheric Sciences, University of Alberta

The game-changing analytics capabilities delivered by InfoSphere Streams also help the University of Alberta to raise its profile worldwide.

"The fact that we showcased our work at the United Nations Convention on Climate Change (Conference of the Parties at Lima, Peru 2014) – the most prominent climate-change decision-making body on the planet today – reflects the quality of the interaction we have with IBM," remarks Dr. Sanchez-Azofeifa. "Our leading-edge analytics capabilities also help us to compete for funding more effectively, as we stand out from the crowd."

The University is planning to expand the scope of its studies by investing in an additional 100 sensors to be stationed in Colombia and Peru. This investment will help the University improve the resolution of its data-capture grid across the Americas.

Dr. Sanchez-Azofeifa concludes: "IBM analytics is the backbone of our groundbreaking research. I would not be able to do what we are doing today without the power of IBM InfoSphere Streams."

For more information

To learn more about how IBM can help you transform your business, please contact your IBM sales representative or IBM Business Partner.

To learn more about IBM InfoSphere Streams, contact your IBM representative or IBM Business Partner, or visit the following website: **ibm.com**/infosphere/streams

To learn more about the research at the University of Alberta, visit: www.uofa.ualberta.ca/research

To learn more about CEOS, visit: www.ceos.ualberta.ca

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