Microsoft

AI for Earth Grantee Profile

SilviaTerra

National forest inventory and carbon offset pilot

Summary

In partnership with Microsoft, SilviaTerra is transforming how conservationists and landowners measure, monitor, and preserve forests. In 2018, AI for Earth awarded SilviaTerra a grant to develop a high-resolution national forest inventory with timber, habitat, and carbon estimates for every acre in the continental US. The first of its kind, the forest inventory enables SilviaTerra to provide landowners with recommendations to improve the value, health, and future of their forests—including providing better access to carbon markets. SilviaTerra is now working with Microsoft to demonstrate the viability and effectiveness of a data-driven, technology-enabled market for small, private landowner carbon. SilviaTerra will be sourcing and selling forest carbon from small private landowners, using an AI for Earth-enabled approach for measurement, algorithmic verification, and monitoring of carbon stocks, with Microsoft as its first corporate carbon credit purchaser.

Incentivizing small forest landowners to keep their trees

Forests are key to helping us solve our most pressing environmental challenges, from climate change to a growing biodiversity crisis. The Nature Conservancy relates that forests and terrestrial soils combined store more than two and a half times as much carbon as the atmosphere—and according to recent research they were involved in, forests could emit less carbon and store much more, with some changes in how we manage our landscapes. In fact, that research indicates natural climate solutions offer up to 37 percent of the mitigation needed between now and 2030 to keep global temperature rise below 2 degrees Celsius.

Forests are not only a pathway to reducing carbon emissions, but they also provide many other valuable ecosystem services. In the US, forests cover over a third of all land, totaling about 749 million acres which can be managed to improve wildlife habitat and purify drinking water. More than half of these woods are privately owned, mostly by families and individual small landowners with 100 or fewer acres. These properties are often vulnerable to development and fragmentation because owners lack the information and resources to practice modern forest management and to participate in ecosystem services markets. By paying landowners for the environmental services their land provides, ecosystem services markets can help protect forests and reward sustainable management.

Sustainable management requires a deep understanding of the forest. But most forest owners have little quantitative information about their land because forests are large and extremely complex. Remarkably,

methods for measuring and monitoring these diverse ecosystems haven't changed significantly in the past two hundred years. Foresters typically gather data by conducting a "timber cruise." This involves surveying sample plots by foot to inventory timber and assess other ecological values, such as habitat and carbon. Timber cruises are labor-intensive and expensive, and because only a small portion of the area is surveyed, the results are often imprecise.

Re-imagining the forest inventory

In 2010, Zack Parisa was a Yale School of Forestry graduate student with two great loves—statistics and the great outdoors. As part of his master's degree work, Zack worked in Armenia with the Armenia Tree Project to support sustainable community forest management planning. This work requires a detailed understanding of the forest structure and condition, but upon arrival, Parisa discovered a pile of hand-written notes from field foresters from the 1950s—not a promising set of inputs for the quantitative decision-making he wanted to accomplish.

> Natural climate solutions offer up to 37 percent of the mitigation needed between now and 2030 to keep global temperature rise below 2 degrees Celsius.

Parisa realized forest inventory was a domain where he could make real change. Together with Max Nova, then an undergraduate at Yale, he founded SilviaTerra with the idea that widely available forest inventory data could help people make better land management decisions. Over the next few years, SilviaTerra scaled up Zack's initial research to a process that combines satellite imagery with machine learning to reduce the amount of fieldwork needed for a forest inventory. Today, millions of acres in the United States are measured with SilviaTerra's technology. But SilviaTerra had an even bolder vision: an inventory and a forest management plan for every acre of forest in America—starting with western Pennsylvania.

Piloting large-scale forest inventory in Pennsylvania

In the western United States, land tends to be heavily dominated by the government or large corporate ownership, but in western Pennsylvania 70 percent of forests are owned by small landowners. Most of these landowners didn't have a quantitative estimate of timber volume or know how much carbon was sequestered on their property, so the area presented an ideal environment for SilviaTerra to deploy its first large-scale forest inventory.

In 2017, SilviaTerra developed a process to generate a large-scale forest inventory for western Pennsylvania. This involved analyzing huge volumes of data, including satellite imagery and fieldwork datasets from the US Forest Service Forest Inventory and Analysis (FIA) program. Then, through a grant provided by Microsoft AI for Earth, SilviaTerra migrated its system to an Azure cloud workflow and scaled its computing process from thousands of acres to hundreds of millions of acres, creating a .05-acre pixel resolution map of forestland across the US via state-by-state deployment. The process combines field measurements from the US Forest Service FIA dataset with a stack of remotely sensed imagery, including Landsat from multiple dates as well as

> The Microsoft Azure platform has enabled SilviaTerra to scale its computing process from thousands of acres to hundreds of millions of acres.

Digital Elevation Maps. The result is the SilviaTerra Basemap, the first high-resolution national forest inventory, with details on the specific species, diameter, and height for roughly 92 billion trees covering 537 million acres. Since moving the model to Microsoft Azure, SilviaTerra is able to process 800 terabytes of mapping data at 100 times the speed they could do before—without the aid of advanced computing power, this would've been an impractically time-consuming process. SilviaTerra will keep the Basemap current by recalculating the forest inventory each year using fresh data and imagery.

SilviaTerra partnered with the Nature Conservancy's Working Woodlands project to turn this data into better decisions for forests in western Pennsylvania. As part of the Working Woodlands project, property owners agree to keep their forested land undeveloped, and in exchange they receive conservation and management assistance. Using SilviaTerra's data, landowners can develop forest management goals and strategies—such as more deer habitat, more carbon sequestration, and sustainable harvests—and different paths and resources to implement these goals.

Changing the market for carbon offset credits

SilviaTerra is not only helping landowners improve the value and health of their forests, but also focused on making it more economical for landowners to keep their properties intact. Through a partnership with Microsoft, SilviaTerra started a project to unlock new sources of carbon finance to protect forests by using the forest inventory map and AI to break down barriers that small landowners face in supplying carbon markets. From measuring and monitoring the forests to managing the paperwork and following the market rules and standards, the overhead costs in time, effort, and money up to now have kept those landowners out. The existing markets also require 99-year commitments from participants, a duration that is impractical for small landowners who often rely on harvesting their trees as their basic income. "Small landowners are often land-

rich and cash-poor," explains Nova. "Forests may be their most valuable asset, so harvesting often helps cover expenses—from property taxes to college tuition."

SilviaTerra's detailed inventory system provides a high-quality, high-integrity means to monitor the status of a forest on a small scale, significantly reducing the costs for assessing the carbon value of the forest. And because the Basemap can be easily updated annually, it also makes shorter-term commitments feasible—even as short as one year. That combination of short terms and reduced overhead opens the possibility to bring in the small landowners and greatly extend the potential impact of carbon offsets.

To push forward this new model for carbon offset projects, SilviaTerra again went to western Pennsylvania, reaching out to landowners through county meetings. With the ability to monitor smaller acreages and offer one-year commitments, SilviaTerra convinced over 20 landowners to join the pilot program. The landowners, wanting to practicing good forestry, were excited to be able to cover expenses without cutting down trees.

> "This is the beauty of the market. Microsoft furthers its commitment to carbon neutrality, while land ownership remains viable and owners continue to be good stewards of the land."—Max Nova, co-founder, SilviaTerra

But of course, a carbon offset program needs buyers to pay the landowners for not harvesting, and that key role was taken by Microsoft. Since 2012, Microsoft has been committed to carbon-neutral operations globally, from reducing its emissions, to replacing fossil-fuel energy sources with renewable ones, to removing carbon from the atmosphere. As part of this carbon neutrality commitment, the Microsoft environmental sustainability team purchases carbon offsets for the company. This team saw the opportunity to build on SilviaTerra's work with the AI for Earth program by purchasing the carbon credits for this pilot—while also demonstrating the viability and effectiveness of a data-driven, technology-enabled market for small, private landowner carbon. SilviaTerra is also using Microsoft blockchain technology to track and retire credits accurately. The joint aspiration is that one day, technology-enabled verification may be able to replace the paperwork involved and perhaps even improve the credibility of offsets, while guarding the measurement integrity that the existing standards offer.

Driving further investment in this type of innovation is essential to break historical patterns of human development and finally decouple economic growth from environmental degradation. Microsoft recently published research commissioned through PwC on the joint environmental and economic benefits of AI innovation in the climate arena. This research showed that large-scale deployment of just a few AI

technologies, in just a few energy intensive sectors, had the potential not only to decrease global carbon emissions by about 4 percent—equivalent to zeroing out the emissions of Australia, Canada, and Japan combined—but also to significantly boost job creation (about 38.2 million new jobs) and the global economy (4.4 percent boost to global GDP).

Cloud-enabled, data-driven technology projects like this one are the focus of Microsoft's Cloud for Global Good program, which offers policy recommendations to help ensure these technologies are evenly shared and play an important role in creating a better world for everyone. As an instance of those policies, the AI for Earth initiative helps explore the possibilities of designing new solutions to build a cleaner, healthier world in which to live. Through this new carbon-offset program, Microsoft expects to retire an estimated 100,000 metric carbon ton-years from the pilot by the end of 2020. "This is the beauty of the market," says Nova. "Microsoft furthers its commitment to carbon neutrality, while land ownership remains viable and owners continue to be good stewards of the land."

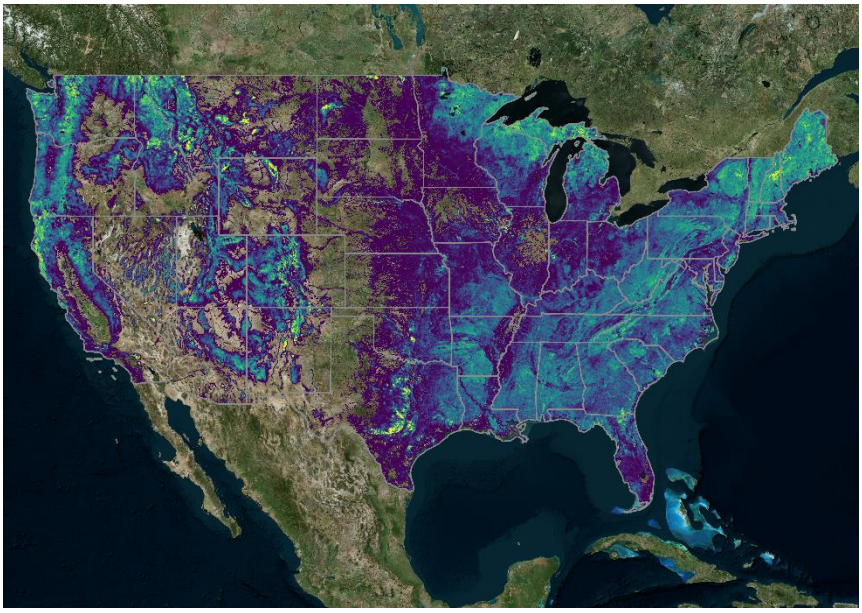
Sharing information with landowners, foresters, and others

SilviaTerra is also working with the AI for Earth engineering team to create an API on Azure that will allow landowners, foresters, and researchers to efficiently access insights from the forest inventory layer. The API will enable landowners to obtain a detailed summary of their property, including timber values, habitat, and carbon. Users simply draw a property boundary on a digital map and SilviaTerra provides the assessment for that plot of land. Ultimately, SilviaTerra envisions offering a dashboard where users can monitor changes to their land over time and get offers from organizations like Microsoft to help improve forests in a monitored way. Additionally, there are a multitude of other use cases for the SilviaTerra Basemap dataset, such as wildfire prediction and response, and deforestation detection.

> "All of this is possible because of the forest inventory Basemap, created through the partnership with Microsoft. It's all built on the Microsoft platform."—Max Nova

The API will provide added benefits for foresters, including integration with existing tools and greater transparency. Many forest managers today use Esri ArcGIS as their geographic information system. ArcGIS holds forest inventory estimates for each management unit of the forest; however, these estimates are often years out of date. Normally, foresters would have to go out into the field and collect new stats, which could take months. But because the Microsoft Azure API interoperates with ArcGIS, foresters will be able to simply click a forest management unit and instantly update it with the latest information from the SilviaTerra Basemap national forest inventory. Additionally, investors and environmental stakeholders are demanding greater

transparency from large industrial timber-owning organizations. SilviaTerra's API will provide foresters with the data to demonstrate their responsible stewardship of the land. Sharing data through the API may also one day help identify critical areas for fire mitigation, allowing forest managers to reduce catastrophic risk of fire.



SilviaTerra Basemap forest inventory. The gradient indicates the density of forest coverage—the lighter the blue, the denser the forest. [Image courtesy of SilviaTerra].

Like the carbon offsets credit program, the work with SilviaTerra on an Azure API comes back to Microsoft's Cloud for Global Good program and AI for Earth—collaborating with organizations to explore the full range of possibilities for using technology to help our environment, for the good of all. "All of this is possible because of the forest inventory Basemap, created through the partnership with Microsoft, and being able to process through terabytes of satellite imagery on the Microsoft cloud. We do all the computations in Azure to figure out the offer we can make to individual landowners. It's all built on the Microsoft platform," says Nova.

About SilviaTerra

Founded in 2010, SilviaTerra is a small team of foresters, biometricians, and data scientists dedicated to expanding our understanding of forests and strengthening our ability to manage these complex and vital ecosystems. SilviaTerra combines its expertise in biometrics with advances in remote sensing and big data analytics to provide cloud-based mobile apps and services for better forest inventory management.

Resources

Website

SilviaTerra

Press

"How AI might be used to battle wildfires." *Wall Street Journal*. April 1, 2019.

"Future wildfires will be fought with algorithms." Fast Company. November 26, 2018.

"Mapping the future of our forests with Microsoft AI." Microsoft. February 4, 2019.

Documentation

Zack Parisa. "Starker Lecture: Forestry in the Age of Artificial Intelligence." Oregon State University—College of Forestry. March 14, 2018.

Justin Adams. "Investing in a forgotten solution to climate change: nature." Global Landscapes Forum. August 29, 2018.

"Nature's Make or Break Potential for Climate Change." The Nature Conservancy. October 16, 2017.

Who Owns America's Trees, Woods, and Forests? Results from the U.S. Forest Service 2011-2013 National Woodland Owner Survey. US Department of Agriculture. March 2015. NRS-INF-31-15.

"Forest Ownership Statistics." National Association of State Foresters. Accessed October 29, 2019.

Jason Kersten and Julian Smith. "Branching Out." The Nature Conservancy. June 1, 2018.

Steve Nix. "U.S. Forest Facts on Forestland: Forestry Land Trend Data in the United States." ThoughtCo. August 13, 2018

Celine Herweijer, Benjamin Combes, Jonathan Gillham. *How AI can enable a sustainable future*. PwC UK. 2019.