



*Ruzilo Boneventura surveys a forest reserve in the village of Kalinzi, in western Tanzania, with a Google Nexus 7 tablet computer as part of a conservation program initiated by the Jane Goodall Institute. (Photo: Michael Christopher Brown/Magnum Photos)*

TAKEPART FEATURES

## Can Technology Save Africa's Forests?

Google's venture with Jane Goodall shows the promise—and limits—of data and devices in the fight against deforestation.

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JUN 12, 2015 · 17 MIN READ



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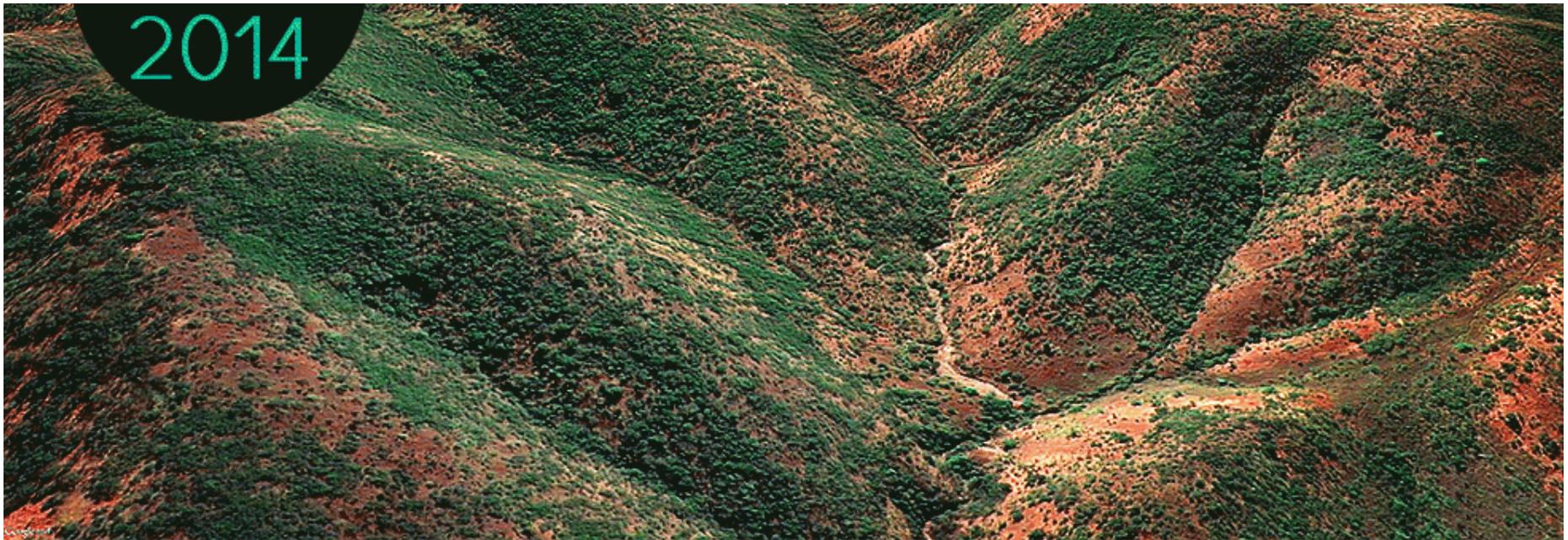
In 2000, Lilian Pintea was getting ready to end his first stint of fieldwork at Gombe Stream Research Center, in Tanzania, when he was invited to stop by Jane Goodall's house for a drink (she prefers Scotch). Goodall tries to spend a few days each year in the place where she made the discoveries about chimpanzees that made her famous, and she enjoys hearing about the ongoing work at what is possibly the world's longest-running continually operated field station in wildlife research.

Pintea's specialty was using satellite photos to show changes to ecosystems. He had come to Gombe by way of Moscow State University in Russia, the University of Minnesota, and the World Bank, to see firsthand how the center's long-term data on chimps, matched to his images, might explain how habitat changes were affecting the animals.

"When you see her for the first time," Pintea recalled of meeting Goodall, "she's a superstar—one of the last explorers." Within two minutes of walking in the door, he was showing her aerial photos, taken over Gombe in 1947, 1958, and 1974, that demonstrated how the landscape had been altered. "She kept saying, 'This is magic. This is magic,'" he said.

These were just low-res photographs taken from planes, but Goodall recognized right away that such imagery would be a fantastic tool for communicating science. Today Pintea is using the next generation of imagery Goodall found magical—some of the same technology we use to navigate to birthday parties in the suburbs, combined with powerful software and tablet computers—to protect and restore forests around Gombe. Pintea is now vice president for conservation science at the Jane Goodall Institute, which she co-founded in the 1970s. He has spent the last decade and a half alongside technology companies including Google—and hundreds of Tanzanians providing critical contributions at every level—mapping, analyzing, protecting, and monitoring the forests around Gombe. The strategy is already being adopted by other organizations (and applied by JGI) elsewhere in Africa, suggesting it can be spread to places such as

South America and Southeast Asia with forests that are even richer in carbon sequestration than the Lake Tanganyika Catchment. What began as a project to save chimpanzee habitat threatened with destruction is showing potential for ancillary benefits for the climate, as the forests where the great apes live store **as much carbon per area as the Amazon**. The potential Goodall saw that day 15 years ago is no longer magic; it's real.



*Forest outside the village of Kigalye before and after it elected to prohibit tree cutting there. (Google/Digital Globe)*

The village of Kalinzi spreads out along tracks of bright-orange dirt, intersected by a two-lane asphalt road, in Tanzania's far west, about six miles from Lake Tanganyika. It consists of perhaps two or three hundred small, often single-room houses of handmade bricks, thatch or tin roofs, and dirt floors—the kind that serve as home for many throughout the region. One day last July I left the nearby town of Kigoma early in the morning and traveled to Kalinzi in a white Toyota Land Cruiser to pick up Ruzilo Boneventura, who lives in the village. As women in traditional dress passed by carrying babies in cloth slings on their backs and shoeless children chased each other around, the vehicle pulled over at one of the dirt tracks and Boneventura hopped in the back. He was going to guide me into a part of a forest where village leaders had decided to ban the cutting of trees. But first we needed to stop by his house to pick up his tablet computer.

Boneventura is a forest monitor

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## Is Reforestation the Answer to Deforestation?

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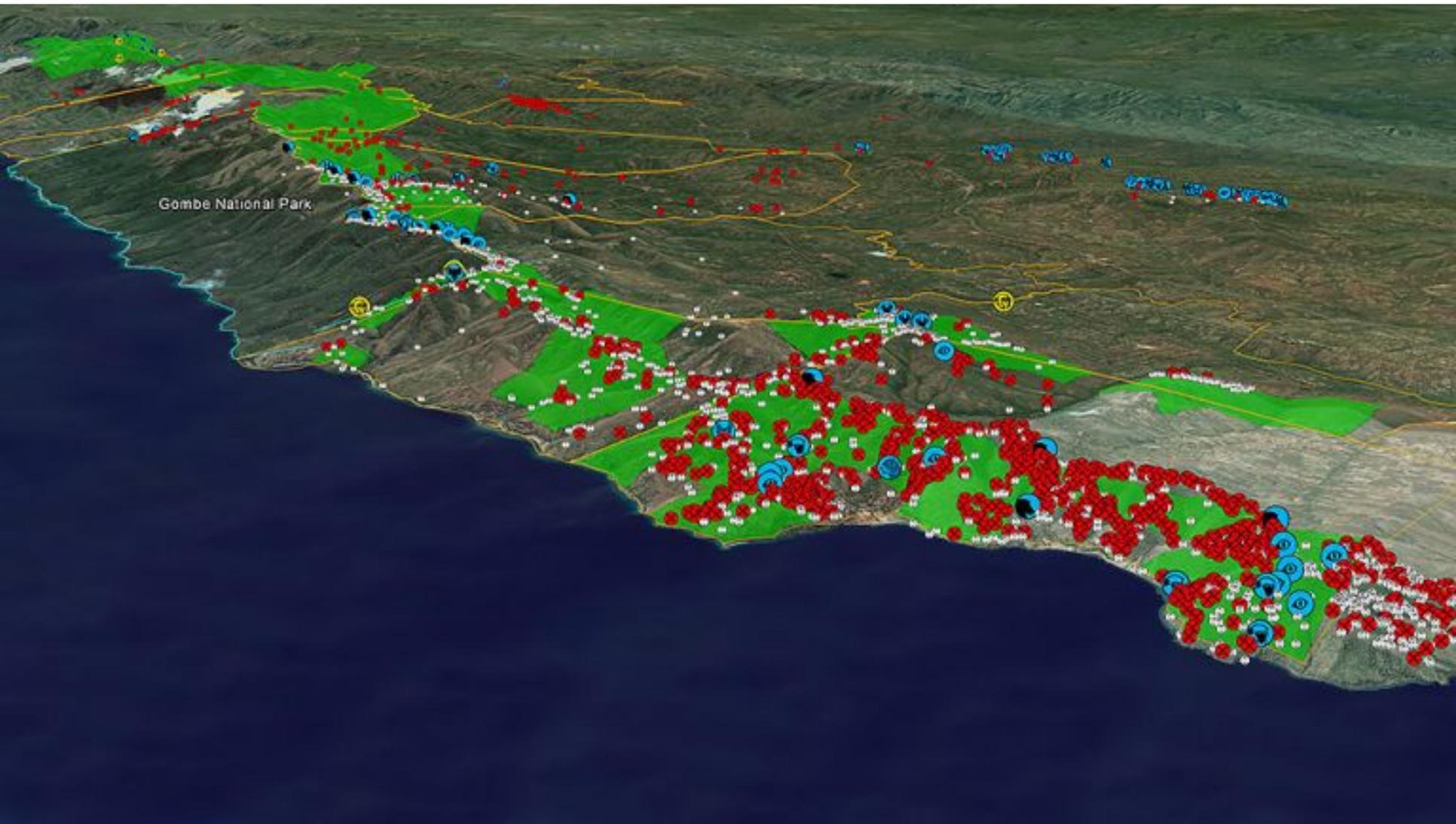
for the village, under a program begun by the Lake Tanganyika Catchment Reforestation and Education Project, or TACARE. A lot of trees had been lost over the preceding few decades,

especially since 1993, when tens of thousands of people escaping ethnic strife and war in Burundi began crossing the border and moving into villages like Kalinzi. Without money to purchase a stove, fuel, or food, an impoverished and growing Tanzanian population, and later the Burundian refugees, were forced to cut trees for firewood and farmland. Goodall realized this was going to be bad for all the primates in the region, human and chimp alike, and launched TACARE about 20 years ago to involve the villages surrounding Gombe in reestablishing degraded forests and protecting those that remained. While conserving village resources, this would benefit chimpanzees by enabling them to travel into and through the newly protected areas—mixing with chimps beyond park borders is considered essential to the Gombe population’s long-term viability.

Boneventura jogged out of his house, his Google Nexus 7 tablet in a waterproof case hanging from his neck, and climbed back into the Land Cruiser. With us was Jovin Lwehabura, an expert in global information systems with JGI who has a master’s degree from the University of Redlands, in California. Boneventura directed us back to the asphalt road, then a few miles south to a dirt track that dead-ended at the forest reserve. We were about a six-hour walk from Gombe Stream National Park, which Tanzania established after Goodall started the research center. “We are poor, and most of our forest disappeared because of our poverty,” Boneventura said. “But we want our forests to flourish and our animals to come back. With less poverty we wouldn’t need to [harvest] the forests, but what else could we do? We need help.”

Boneventura traverses this area, by foot, about 10 times a month for nine hours at a time, earning 40,000 Tanzanian shillings, or about \$25 (lunch at a restaurant in Kigoma costs \$3). His Nexus is loaded with Open Data Kit, free open-source

software that enables easy collection of data in the field; mostly used in public health, the software has been customized for TACARE's purpose. After cataloging illegal activity, signs of wildlife, or anything that seems out of place in the protected zone, Boneventura travels to Kigoma about once a month to upload his entries to the Google Cloud. Lwehabura later analyzes the data so communities can decide what to do about whatever Boneventura and the other villages' forest monitors have found, and conservation scientists can track how the program is working.



*Data points collected by forest monitors outside Gombe Stream National Park in Tanzania. Yellow indicates chimpanzee presence; blue represents other wildlife; red is potentially illegal human activity; white is areas patrolled. The bright green areas are village forest preserves. (Image: Lilian Pintea/Jane Goodall Institute; map data: Google/DigitalGlobe)*

Boneventura showed me how he taps through the menus to record various data, such as the appearance of a chimp nest or signs of cattle grazing. It was a strange experience to stand in a forest in Tanzania and get the same demonstration of technology, through a Swahili translator, I had received two months earlier at Google's headquarters in Mountain View, California. He said that since he started

this work in 2006, using pen and paper, he has seen “great changes” to the forest around Kalinzi as well as to local attitudes regarding its protection. “People still go to poach trees,” he said, “but they go in hiding and aren’t able to take as much.”

JGI has designs on expanding this work far beyond Gombe. About 75 miles south of Gombe is Mahale Mountains National Park, home to some 400 chimps. Forty miles to the north is Burundi’s Vyanda forest reserve, home to 50 more, and about 70 miles north of that is Kibira National Park, home to roughly 450 more. Another 25 miles north can be found nearly all of Rwanda’s remaining 300 to 400 chimps, in a park contiguous with Kibira at its southern end and, to the west, just a few miles from the border with the Democratic Republic of the Congo, which is believed home to about 93 percent of the eastern subspecies. (All subspecies of the common chimpanzee are endangered, having lost 85 percent of their population in the 20th century.) With **60 percent** of Tanzania’s roughly 2,700 chimpanzees living outside national preserves, protecting habitat through local efforts and processes would be a significant step toward establishing the land around Gombe as one small section of a boomerang shape of chimp-friendly forest connecting virtually the entire population. “Recovery of that habitat is essential; it’s really important work,” said Sam Wasser, director of the Center for Conservation Biology at the University of Washington.



*Lilian Pinteá, vice president of conservation*

By the time Pinteá had that glass of Scotch with Goodall, TACARE was working in local communities for several years. Goodall described the strategy to me one time I visited her house at Gombe: “No white people marching in, puffing themselves up and saying, ‘You’ve made a mess; we’re going to put it right,’ ” she said. Rather, the approach was to ask the people whom JGI proposed to help what it was that they wanted. Odd though it may seem, this was unusual among charities and NGOs in the developing world from the time of the missionaries through the 1990s. The locals responded: health care (which Goodall had personally been providing almost from the day of her arrival at Gombe, in 1960) and education.

Sustainable development would diminish people’s need to chop trees, certainly, but the goal of TACARE was to get residents’ interested in JGI’s conservation mission, leveraging local knowledge for the purpose. Once the antipoverty efforts led to local buy-in, the financial and other benefits of conservation were explained. Though some were nonetheless skeptical, the trust TACARE built, by the time Pinteá got to the organization, allowed it to begin serious work restoring and preserving the forests outside Gombe.

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JANE GOODALL

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**While Pinteá was combing through satellite imagery,** Rebecca Moore, today the engineering manager for Google Earth Outreach and Earth Engine, was a software engineer writing code for voicemail systems. One day in 2005, she and about 2,000 of her neighbors in the hills above Los Gatos, California, received in the mail a “notice of intent to harvest timber.” Included was a black-and-white

topographic map purporting to show the area in her neighborhood—just over the hill from Silicon Valley—where the logging would take place.

“Nobody could read it,” Moore told me. The map was what designers call “busy” yet lacking in detail. It was dense with squiggly lines and black dots, but the key didn’t include all its elements, and features such as reservoirs and roads Moore knew to be there were entirely absent. Moore had been using software developed by Keyhole Inc.—which would later become Google Earth—to map bike trails and emergency evacuation routes in her neighborhood. She wondered if she could figure out from the notice she had received, which she suspected was deliberately opaque, what the logging company was planning, remap the whole thing in Keyhole, and show the results to her community.



*As villages outside the park shared the interest of protecting watersheds, areas they decided to preserve were largely contiguous to each other and contiguous to the park—effectively creating new wildlife habitat. (Illustration by Marc Fusco)*

Moore used a tool—still available in Google Earth—called a “flyover” to show the proposed logging area. It demonstrated that helicopters would be carrying tree trunks potentially several feet in diameter over homes, schools, and playgrounds. The flyover was a new capability of technology in a part of the world that gets

hugely excited about new capabilities of technology, and Moore's was shown on the local broadcast news, to the editorial board of the *San Jose Mercury News*, and to her representative in Sacramento. And that was pretty much the end of the logging plan.

Moore still keeps a copy of the map and screen shots of her flyover pinned to the wall of her office. She looked out the window at the redwoods growing there, like the ones that were to be harvested from near her home a decade ago, and told me how shortly after Google bought Keyhole, the company asked Moore to come by and give a talk. Her father, a crusading attorney, and her brother, a painter, had both just died, and she became troubled that her work failed to live up to their legacies. The experience with the logging company convinced her that the software she had used to rid her neighborhood of loggers "could transform grassroots environmental activism and empower local communities," she said, and following her talk at the company, she told Google she had analyzed Keyhole's code and believed that if the company made eight or 10 adaptations of the software, Google Earth "could be extremely powerful for these other uses." Google offered her a job, and she quickly asked permission to start the Global Awareness folder in Google Earth as a tool for conservation scientists, NGOs, and grassroots activists. She got the go-ahead and, being a fan of Goodall's, soon cold-called JGI, saying, "We have this tool, and we want to help you use it in your work."



*A juvenile chimpanzee in Gombe Stream National Park in July 2014. (Photo: Michael Christopher Brown/Magnum Photos)*

**At that point Pinteá had been showing people in the villages around Gombe satellite images** to a resolution of one meter. Because of the gender-based division of labor in local society, men and women have different understandings of the landscapes they share, so he made it a priority to meet not just with village leadership, which tended to be male-dominated, but also women's groups. Many of the people Pinteá met with couldn't read; some had never seen a map. Nevertheless, he told me over lunch in a Cuban restaurant outside Washington last spring, "it was very clear there was a lot they could see in this spatial technology. You could see them travelling through the images in their brain. A woman said to me, 'This is the tree where I lay my baby down to sleep while I'm farming.'" Local understanding began to integrate with scientific knowledge.

In 2006 JGI began work on a 30-year regional conservation action plan. DigitalGlobe, the world's largest provider of high-resolution satellite imagery,

provided photos at no charge. Using software provided by Esri, a geographic data company whose annual conference is like Comic-Con for geospatial geeks, Pintea created maps from the images. Each village would use these to develop its own land-use plan, which included demarcated areas for housing, agriculture, grazing, and other uses, including a forest reserve. Pintea showed me a picture of one of these meetings: Tanzanians stand over a map drawn in the dirt with a stick; leaves indicate the set-aside forest area. That broad outline was later georeferenced with GPS and added as a layer, using Esri, to a new map of the village's future.

Locals had already begun to see the extremes in the dry and wet seasons that computer models of climate change predicted, which with the effects of deforestation were contributing to essential water sources getting buried by erosion. They asked the experts from JGI what they could do about that. “We agreed it was a good idea to put forest in high elevation for watershed integrity,” Pintea said. Guided by the CAP and the villagers and driven by Esri software, not only did each community establish forest reserves but all the reserves ended up contiguous to each other—and contiguous to Gombe. “There was a good overlap of conservation goals and human livelihood goals,” Pintea said. “Important ecosystem services were overlaid with important biodiversity habitat.” Not all the villages devoted as much to forest reserve as TACARE hoped they would, but 76 percent of its target was met. “You can't tell people, ‘You have to set aside 10 percent,’ ” said Anthony Collins, a researcher at Gombe for 40 years who is also involved with community relations and TACARE. “It's their responsibility, and you can't impose any figure.”

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Putting a tablet in someone's hands is not enough. You have to change the culture of local institutions and stakeholders, and that takes more than technology.

LILIAN PINTEA, VICE PRESIDENT FOR CONSERVATION SCIENCE, JANE GOODALL INSTITUTE

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One of the places these conversations happened was in Kigalye, the second village one passes when heading south along Lake Tanganyika from Gombe. It's home to about 4,000 people, heavily reliant for calories and income on fish from the lake, and accessible, for practical purposes, only by boat. I talked to the chair of the village council, Hussein Mussa Kasala, a very tall, 50ish man with large brown eyes and a triangular face, in one of the village's schoolrooms. He told me about when TACARE first arrived in the village, almost two decades ago, and village leaders told of their needs. I also met Dbadia Mkone, a doctor JGI pays to travel by boat from Kigoma to treat village residents, mostly for malaria, and Subira Hamisi Mpenda, a woman of about 30 dressed head to toe in red-and-black stripes. She said she had needed to leave school at seven to help her family, but with a JGI scholarship she received, she progressed from second-grade level to 11th in only a few years attending school in Kigoma, and she hoped to go to college.

Visible outside the classroom window was a steep slope covered with short trees and rising a couple hundred feet above the village. By the early aughts, the slope's trees had been entirely harvested for firewood; roots that had previously held the dirt in place during the rainy season were dying, and one stormy night around the time the village was beginning work on its land-use plan, a river of mud poured down the hill into the village, killing several people. The village council and the committee that developed the land-use plan didn't need any more convincing to include the slope in the portion of Kigalye that would be off-limits to tree cutting. These areas are already growing back (see illustration above), and while they will help prevent erosion in Kigalye, the effect of their sequestering carbon will be broader. JGI assessed biomass content on 31 clusters of similar vegetation south of Kigoma, from which carbon content can be roughly determined. Though the degree of confidence in the estimates is low, the survey found that woodland could be storing 12 times as much CO<sub>2</sub> as farmland, and lowland forest 22 times more; grassland holds about a third to a quarter as much carbon as the other vegetation types. Once the woodlands in Kigalye and other villages are fully restored, they are expected to sequester greenhouse gas emissions at similar rates.

Enforcement was a challenge. Forest monitors like Boneventura were hired and given GPS units; they would walk the reserves, mark the location of any indications of activity, and note by hand the type. Every month they'd give their notebooks to Lwehabura.

This analog system was producing 30,000 waypoints a year—far too much data to log by hand. Aggregating, analyzing, visualizing, and sharing data were also impossible. With the advent of the smartphone, the game changed dramatically. Moore was working with [Amazon tribespeople](#) to use Android devices to document and report illegal logging on their land, and she invited Pinteá to Brazil to show him how it worked. In 2009, the chief of the Surui tribe and Goodall met in Copenhagen to address the COP 15 climate meeting, and they described how JGI and grantors were paying locals to collect critical scientific data—putting money into impoverished rural communities while advancing conservation goals. More than 100 people were trained in Tanzania, with more in Uganda and the [DRC](#), and a three-year grant from NASA will put 500 mobile devices in the hands of community representatives, park rangers, and others, to help crowdsource a habitat health index across chimps' entire range. The habitat created by the village land-use plans seems pretty healthy: Researchers at Gombe have recently identified, through DNA analysis of scat, two chimps in the park that are unrelated to any known to be living there, meaning they must have crossed over from outside park boundaries.

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Moore told me a story that showed how technology and local understanding are mutually reinforcing. A forest monitor was aware for years of a chimpanzee trap that a farmer, upset that chimps were stealing his crop, had set in a riverine forest near his property. Nobody knows how many chimpanzees were speared to death through the holes in the roof of this trap. The forest monitor informed law enforcement of the illegal trap, but they didn't do anything about it. The first day the forest monitor got his Android device, he went to the trap, photographed it with time and date and geolocation stamps, uploaded it to Google, and brought the device to police to show them what he had previously only been able to tell them. Moore said, "He could finally say [to police], 'Maybe you don't care about this, but there are a billion people looking at this on Google Earth now, so what are you going to do?'" Pinteá said the trap was destroyed within days. "When you show the community a data point collected from the forest monitor, it has a credibility it doesn't have when it comes from outsiders," he said. "It's not some scientist's data, or a foreign NGO's; it's their own."

Soon this will be happening in the opposite direction—from the cloud to the ground. Global Forest Watch, an online tool Google developed with World Resources Institute and the United Nations Environment Programme to track changes to forests using satellite imagery, will enable forest monitors (or anyone else with a mobile device) to receive alerts of potential deforestation in a selected area. Offline, they can take the device into the forest reserve to provide essential ground truth to the Global Forest Watch survey. Given a more targeted area to search, forest monitors like Boneventura should become much more efficient. New software will provide data collected by forest monitors directly to decision makers in places like Kigalye and Kalinzi that lack broadband Internet access, helping communities halt deforestation in its tracks.

The system today doesn't always work the way it's supposed to, however, and it seems that all the one-meter-resolution satellite imagery, \$35,000-a-year software, and mobile devices won't fix that without the commitment of humans. In the village of Kasuku (its population is around 8,000, about half of whom appeared to be under 10), I met Martha Joseph, 49, a farmer and a mother, and Musa

Hamisi, 38, a driver. Joseph and Hamisi are both HIV positive and were diagnosed and introduced to treatment options through fellow Kasuku residents volunteering for JGI in the village. Hamisi was too sick to work when he was tested, eight years ago, but, like Joseph, he is now on antiretroviral therapy and says he is healthy.

The improvement in Hamisi's health, thanks in part to JGI, opened him to its discussions of conservation. "I thought it was a waste of time" before, he said. "I didn't care." Today he's among the leadership of the village's conservation committee and owns a three-acre plot of deforested land that he's allowing to recover and from which he harvests mushrooms and downed branches. He also told me that a group of HIV-positive villagers he organized for counseling and job training maintains beehives in the forest the village set aside as a protected zone. Joseph said she, too, keeps bees in the area; they agreed that the honey helps with their health, and they sell the extra. I asked if they'd take me there.



*Musa Hamisi and Martha Joseph are HIV-positive Tanzanians helped by the Jane Goodall Institute's programs who have come to support its reforestation initiatives as well. (Photo: Michael Christopher Brown/Magnum Photos)*

Curious children chased our vehicle off from Joseph's house, and we drove over Kasuku's double-track path, passing the goats and chickens wandering around like they do just about everywhere the very poor live. After 15 minutes or so the Land Cruiser arrived within the boundaries of the set-aside portion of Kasuku's forest, a scrubby landscape of dry ground and trees ranging from saplings to maybe 10 feet in height. Lwehabura, who joined us, explained that the original forest had been much taller, but by 2010 or so it had been chopped down to the roots; any growth I could see had occurred since the village land-use plan was put in place.



*Musa Hamisi burns the belongings of people presumed to have been operating the charcoal oven that smoked out his beehive in a protected forest. (Photo: Michael Christopher Brown/Magnum Photos)*

After a few minutes more the vehicle could not easily pass any farther, so we got out to walk. Not long after leaving the Land Cruiser I noticed a few branches that had been chopped. Bright-red sap oozed from the scars. Then a pair of women passed us in the opposite direction, carrying bunches of sticks on their heads—a common sight in the region, but this was supposed to be a conservation area enforced by village leadership. A minute or two later we passed a woman in the act of chopping a tree. Joseph reprimanded her with some strong words in Swahili and a wagging finger. The woman apologized, saying she didn't know she wasn't supposed to harvest wood there; Joseph responded with what is basically the Swahili word for “bullshit.”

It was easy to interpret this as a bit of improvised theater for the benefit of an American reporter. What was clearly not orchestrated for my benefit was what

happened a hundred yards or so on, when we arrived at the hives. First we saw a couple of men run off, deeper into the forest. Right near Hamisi's and Joseph's hives, somewhat shielded from view, were two charcoal ovens. These were handmade constructions of rock, sticks, and earth, perhaps 20 feet long by eight feet wide, that sloped down from a knee-high opening to where they joined the natural earth. People use them to slowly cook the moisture out of wood, making it into a more efficient fuel for heating or cooking that is widely sold in bundles by the side of the road [across rural Africa](#). Charcoal ovens must be constantly tended; these were hot and smoking, apparently the work of the men we'd seen run away.

The smoke had dispersed the bee colonies. Discovering that their food and income source had been destroyed, Hamisi and Joseph were upset. Hamisi walked off to where I could not see him, leaving Joseph and me with Lwehabura next to her empty hive. "We will talk to the village leaders and see what can be done," Lwehabura said to me in English. He said something in Swahili to Joseph, but whatever it was it didn't seem to be much consolation. Her eyes watered.

I heard a noise and followed it to the other side of some bushes, where the ovens were. Hamisi had found the oven operators' gear—a large plastic bowl, a tin teakettle and cooking pot, and two bundles of clothing. He had apparently taken a big rock and broken the pot with it. Now he lifted the rock above his head and threw it down on the kettle, crushing it, and did the same to the bowl. Looking like he was either going to burst into tears or spit with rage, he was taking from the men as they had taken his bees from him. Next he broke the bowl. Then he gathered the bundles of clothes, carried them over to the opening of one of the ovens, and stuffed them in.

We drove Hamisi and Joseph home and thanked them, then returned to Kigoma. It was lunchtime, and Lwehabura knew a place—Sun City, where we sat on the porch and ordered *dagaa*, a tiny fish from the lake, lightly fried. "My impression is the leaders of [Kasuku] are not serious," Lwehabura said. "It's a very different story than Kigalye—there they learned their lesson with the mudslide."

I remembered something Pinteá had said to me in the Cuban restaurant outside

Washington: “Putting a tablet in someone’s hands is not enough. You have to change the culture of local institutions and stakeholders, and that takes more than technology.”

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