

World Watch Institute Sustainability in the Tropics

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In the early 1970s, facing overwhelming obstacles, a young visionary named Paolo Lugari set out to build a sustainable village on los llanos, the remote plains of Colombia, some 500 kilometers east of the country's capital, Bogotá. Lugari and a diverse and creative team of collaborators worked on the supposition that if it could be done there, it could be done anywhere. Supported by ingenious renewable energy technologies, hydroponic farming techniques, and-improbably-a regenerating rainforest, Las Gaviotas has survived and flourished for 30 years, even in the midst of Colombian internal conflict.

The son of an Italian geography professor whose fieldwork led him to settle in southwest Colombia, Lugari first visited the inhospitable llanos in the 1960s. Here, during the December-to-April dry season, a merciless tropical sun bakes the savannah; the rest of the year, severe rains inundate the landscape, making the unpaved roads impassable for several months. In this climate, forests exist only alongside permanent streams, which thread the savannah like tendrils creeping upland from the massive rivers that drain the eastern slopes of the Andes into the Orinoco River and finally the Caribbean Sea.

At a time when the OPEC oil embargo was creating worldwide energy shortages, the restless Lugari conceived the idea of returning to the llanos to build a sustainable village that would support itself with renewable energy. During the first trip with his brother, Lugari camped in an abandoned and overgrown settlement originally meant to support construction of a road that was never built. A visit to their camp by a yellow-billed tern (*Sterna superciliaris*), commonly called gaviota (gull) by the local people, inspired the name of the project.

Lugari assembled a team of engineers, artists, students, natives, and even orphans from the streets of Bogotá. Among their early products was a super-efficient turbine to generate 10 kilowatts of electricity from the flow over a small dam just one meter in height. Later they created a double-action tail-less windmill, which can capture energy from fleeting breezes yet has the mechanical strength to withstand gusts in the violent thunderstorms of the rainy season. Another effort led to a novel manual pump that can extract water from far greater depths than conventional pumps, enabling users to reach the savannah water table even in the dry season. In a typically creative application, Lugari's team attached one of the pumps to a seesaw, so that kids can do useful work and learn about their water source, while having fun at the same time. Experiments with local soil allowed the team to create adobe pipe systems and mechanically pressed bricks. Still other research led to the development of a solar water distiller to obtain pure water for medical emergencies and vehicle batteries, as well as solar-powered hot oil cookers.

Sustaining the Village

The early accomplishments of Las Gaviotas earned support from the United Nations Development Programme, among other international agencies. In the 1980s, the Las Gaviotas team was hired to install their innovative "appropriate technologies" in other parts of the country. This work included installation in many villages of water systems based on the Gaviotas windmills and pumps. The largest single effort was a solar hot water system for Ciudad Tunal, a 6,000-apartment public housing project in Bogotá. The units still work perfectly, owing greatly to the fact that they require no moving parts.

One notable project undertaken at Las Gaviotas in the 1980s was the design and construction of a remarkable self-sufficient rural hospital facility. Despite external temperatures that can exceed 38 degrees Celsius, with

very high humidity, the one-of-a-kind facility provided appropriate climate control for an operating room, using bioclimatic technologies such as subsurface tunnels and double ventilation systems on the walls and roof. The kitchen featured solar cooking, although repeated efforts to design an effective solar refrigerator never succeeded. Patient rooms included louvered windows for ventilation and sliding roof panels that would admit daylight and allow for disinfection by exposure to ultraviolet sunlight. The hospital was enhanced by a maloca, a tall open-sided thatch-roofed structure built by indigenous Guahibo neighbors to provide shelter for families of patients staying close to loved ones.

Unfortunately, in the early 1990s a new national health-care policy, modeled on the U.S. managed-care system, led to closing of the hospital. The low population of the llanos could neither support three permanent doctors (as the law demands) nor meet the statutory minimum subscriber base for an independent health-care cooperative. However, in a creative transformation facilitated by its award-winning modular design, the sterile facility became a bottling plant for Gaviotas' Tropical Drinking Water. Distributed free to local residents, the potable water serves public health perhaps even more effectively than the hospital did, because medical emergencies are rare and the clean water has helped to greatly reduce the once-high rates of gastrointestinal disease.

As internal strife grew in Colombia in the 1990s, Las Gaviotas remained an oasis of harmony: anyone looking for medical care was welcome. The egalitarian social structure of the village, where everyone's ideas and opinions contributed to community decision-making and no one held a position of authority, made its lack of defense its most important strength. In the end, the social and cultural value of Gaviotas allowed it to transcend the violence.

Regenerating the Forest

From the outset, food supply for the village was a major challenge due to the acidity of the savannah soil and its low fertility when measured by conventional methods. Streams provided fish, the widely scattered ranches on the isolated llanos provided beef, and the streamside forests provided fruits, but growing staple crops in local soils proved impossible and the village came to rely on hydroponic gardens. "These soils are very poor, but only to poor brains," Lugari says. Part of his dream, based on knowledge that thousands of years ago the savannah was part of the Amazon forest, was to find a way to regenerate forest areas. This quest forms the latest and most significant chapter in the evolution of Gaviotas.

Beginning in the 1980s, experiments with the acidic soil of the llanos took root. When inoculated with a specific mycorrhizal root fungus, the Caribbean pine (*Pinus caribaea*), a species native to Central America, could grow in the "poor soil" of the savannah. The consequences seemed almost miraculous. The newly rooted seedlings provided shade, leading to lower soil temperatures and greater moisture penetration and retention. Between the pines, other plants started to grow and, contrary to the practice in monoculture plantations, were allowed to flourish. All contributed to building soil. As the pines grew to many meters, the understory supported an explosion of biodiversity, with botanical studies reporting more than 190 different plant species. Animals have followed the plants, and the emerging ecosystem will continue to develop as the pines reach maturity. Because the pines are sterile in this habitat, however, they simply serve the role of catalysts in regenerating the rainforest.

After 1990, the forest provided a new economic base for the resilient village. The Caribbean pine produces abundant resin, and for reasons still unknown, Gaviotas resin production is particularly high. With use of an anticoagulant, cuts in the bark lead to resin production for about two weeks until the tree seals itself again. The resin trickle fills a 50-gram bag in one week, yielding more than 3 kilograms in annual production. This process can begin when the tree is 10 years old and can be carried on continuously for 5 years. After a few years of rest, the process can be repeated without adverse effect on the tree.

Workers collect the small bags of resin into larger ones and load them onto a flatbed truck on a roadway that serves the dual purpose of forest access road and fire break. The truck delivers to the "biofactory," a state-of-the-art distillery designed by Gaviotas engineers and powered by a steam/electrical cogeneration plant, itself fueled by lumber harvested to thin the growing forest and maximize forest growth. In the factory, the tacky resin is liquefied, while the bags are recycled. After filtration and sedimentation, the mix goes through a distillation process that yields turpentine and a residue known as colophony or rosin. The liquid turpentine is drawn off the top into steel drums. In a remarkable prize-winning innovation, the Gaviotas team designed a triple-layered cardboard container to receive hot rosin. Upon cooling, the rosin cools and solidifies in 25-kilogram blocks, providing an easy medium for shipping and simple extraction by the end user. No part of the distillation process requires additional chemicals.

Both turpentine and rosin are valuable sales products. Turpentine finds universal use as an organic solvent and disinfectant; it also is used in the production of fragrances. Rosin is a component of products as diverse as glossy papers, paints, and cosmetics, as well as the gripping agent used for violin strings and baseball bats. The domestic Gaviotas rosin production helps to displace costly imports. In addition to these products, the Las Gaviotas arbochemistry program plans more sophisticated biorefining to yield 12 other products, including oils and fragrances.

The initial achievement of viable forest growth led to a massive tree-planting effort. During the three-month planting season, an imported American tractor-now fueled by raw palm oil, eliminating the need to import diesel fuel-pulls a Gaviotas-designed double-rowed planter. This machine makes it possible to transplant 30 nursery seedlings per minute, 24 hours every day except Sundays. Since the initial planting in the early 1980s, the forest has grown to 8,000 hectares.

Besides generating resin products, the forest yielded a serendipitous bonus: systematically cooler temperatures over the forested land have caused a local increase in rainfall. Moreover, the increasingly rich biomass in the soil provides more effective filtering. Wells under the forest now yield drinking water of the highest purity, which is bottled along with tropical fruit juices in the sterile facilities of the converted hospital. Thus, the forest provides an enhanced supply of safe drinking water as well as additional sale products to support the village. With characteristic creativity, the Gaviotas team has designed plastic bottles for reuse as interlocking toys.

Expanding Social Sustainability

Las Gaviotas is managed to provide employment for as many people as come to work. The village now supports some 200 laborers, who earn daily wages on a task-based scheme that pays at least double the national minimum wage (which is about \$200 a month), in addition to room, board, and medical care. Among the workers are a large percentage of long-time residents—we met gray-haired Pompilio Arciniegas, who recalls planting the very first tree more than 20 years ago, and Henry Moya, whom author Alan Weisman described as an 11-year old in the 1970s—joined by young men from outside the village attracted by the idea of earning an income that would help them legitimately satisfy the needs of their families. Other workers come eagerly to a place where they do not have to live in fear of the civil unrest. Aside from the direct jobs provided, more than 3,000 people receive indirect benefits from Gaviotas.

The village itself has about 50 resident families, totaling about 200 people. Over the years, some 30 children have been born in the village and some 500 children from the village and from the surrounding region have attended the Gaviotas school. Adult residents rotate among the various jobs in the village, from construction to planting to gardening to cooking. Among other benefits, this equips everyone to contribute creatively to improving productivity and to overall satisfaction. Four residents are on pension after working for 25 years.

The success of Las Gaviotas in sustainably supporting the community from the products of the regenerated rainforest has prompted new dreams of expanding the forest across the savannah, with both environmental

and social benefits. A map on the factory wall shows the regions of Vichada province that have sufficient drainage and appropriate mineralogy. The total comes to 3 million hectares, nearly 400 times the present size of Las Gaviotas, without consideration of additional land in neighboring Meta province. Carbon sequestration by the growing forest is estimated at 18 tons per hectare, so that the forest will sequester about 50 million tons of carbon per year during its 50-year growth cycle, offsetting roughly one-quarter of Colombia's entire projected contribution of global greenhouse gas emissions during this time.

The expansion of a Gaviotas-inspired biodiversity project to such a scale would employ tens of thousands of workers and support hundreds of thousands of people. Lugari's enlarged dream conceives these people living in scores of economically, socially, and environmentally sustainable villages in productive harmony with nature. Achieving this would change the living conditions of a great part of the Colombian people and transform the world's view of the country.

Plans to achieve this extraordinary environmental and social transformation, beginning with a tenfold expansion of the forest around Las Gaviotas, won endorsement from President Alvaro Uribe in 2004. Moreover, to support the project, the Colombian Air Force has offered a site for the initial replication of the Gaviotas initiative. The name of the place is Marandúa, which in the local dialect means "bearer of good news." The land encompasses about three-quarters of a military reserve that occupies over 70,000 hectares, about 100 kilometers from the Orinoco River in eastern Vichada. This Air Force commitment to sustainable development as a path to peace is unprecedented in the history of any Latin American military.

Partnership with ZERI

An important partner and promoter of the Marandúa reforestation project is Zero Emissions Research and Initiatives (ZERI), led by Belgian entrepreneur Gunter Pauli, one-time CEO of the ecological home products manufacturer Ecover. Pauli founded ZERI in 1994, following the realization that even his biodegradable products depended on a system of production that was unsustainable. Under his leadership, ZERI propagates the "uncompromising, but self-evident" sustainability standard of zero waste, fosters research needed to bring it to reality, and implements systems conceived to build value by taking residues from one enterprise as raw materials for others, rendering the very concept of "waste" anachronistic. ZERI has generated projects on five continents. They include the Montfort Boys Town in Fiji (see *World Watch*, July/August 1997).

Pauli initially met Paolo Lugari in 1984, when Pauli visited Colombia with his mentor Aurelio Peccei, founder of the Club of Rome (which is best known for commissioning the groundbreaking 1972 study *Limits to Growth*). Recognizing in Las Gaviotas a living example of the principles he espouses, Pauli has become its most vocal champion as a world model of sustainable development. ZERI has supported the efforts of Las Gaviotas by generating close to \$100,000 in private donations. It has also assisted the Marandúa project by searching for international investors under the standard of "corporate social responsibility," as well as by implementing innovative funding mechanisms.

One such mechanism couples two components of the reforestation system: carbon sequestration and the production of pure water. In the face of growing demand for both products, Las Gaviotas is seeking longterm contracts to provide drinking water, providing incentives for institutional buyers to secure carbon sequestration certification under the Kyoto Protocol. Such contracts would offset the buyers' carbon emissions (and those resulting from overseas transport of the water) by financing the planting of new, biodiverse forests.

The second mechanism for financing the reforestation effort is ecotourism. Colombia is a nation of extraordinary biodiversity, owing to its location in the tropics and its range of habitats, from coasts on the Caribbean and the Pacific, to the three spines of the Andes that divide the country with peaks as high as 5,800 meters above sea level, to the vast plains and rainforests of the eastern provinces. Among the attractions of the eastern savannah is the pristine Tuparro National Park, which lies just across the Río Tomo from

Marandúa. Although the domestic violence that has plagued Colombia has limited tourism and ecological research, the potential for future development is enormous.

In the spring of 2005, after almost 10 years during which the conflict prevented the visit of any outsiders, foreigners and Colombians alike, the authors had the privilege of visiting Las Gaviotas and Marandúa with tours led by Gunter Pauli. The timing of the first visit, in May, was dictated by the filming of a documentary by Fuji TV that would be broadcast in early June during a state visit by Colombian President Uribe to Japan.

Through efforts such as water sales, international site visits, and high-level diplomacy, the Marandúa project is becoming a reality. This growing fruit represents the organic development of the dreams and efforts of many people: Paolo Lugari himself, the Colombian government, the Air Force commander-in-chief and his deputies, a Belgian entrepreneur who believes in Colombia, and many others who trust in the great potential offered by the richness and biodiversity of the country. The ultimate dream is that the reforested savannah will become home to hundreds of thousands of people who will be able to live in peace and contribute with their work to generating wealth in one of the cleanest environments in the world.

Spanning one wall of the community center in Gaviotas is a colorful mural painted by a local artist who signs his work only with his ID number. The mural portrays the past, present, and future of Las Gaviotas, along with the artist's dreams: residents and their children at work and at play, making music and dancing amid a rich company of indigenous wildlife. In the center of the mural is a sign: "Maturity consists of making dreams come true." Paolo Lugari is fond of saying: "If you aren't dreaming, you must be asleep!" The waking dream of Lugari and his fellow Colombians shines as a beacon of hope in a troubled world.

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