



PROPOSAL: AGROFORESTRY BELTS TO RESTORE WATERSHED HYDROLOGY

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SUMMARY

In recent decades, the Nandamojo Valley watershed on the northern Pacific coast of Costa Rica has changed radically. Seasonal flooding has intensified, and riverbeds that used to flow year-round are now dry for several months each year.

These changes are largely due to a dramatic shift in land use. Much of the dry tropical forest, which once covered most of the valley,

has been cleared to make room for cattle ranching and monoculture crops and forestry. This has reduced the valley’s ability to absorb and infiltrate water during Guanacaste’s rainy season. As a result, the valley’s fertility, productivity and ability to support human activity are declining.

In response, Restoring Our Watershed (ROW), a non-profit organization dedicated to protecting and restoring the valley, intends to pilot an innovative “agroforestry belt” project. This program will help restore the area’s hydrology, maintain soil fertility, and mitigate the negative effects of climate change.

“**Agroforestry** intentionally combines agriculture and forestry to create integrated and sustainable land-use systems... [it] takes advantage of the interactive benefits from combining trees and shrubs with crops and/or livestock.”
*-United States Department of Agriculture
 National Agroforestry Center*

ROW serves the needs of people who live in a damaged ecosystem by giving them the tools and resources necessary to improve conditions, rather than imposing a top-down solution. Consistent with this approach, we have identified agroforestry belts as an optimal tool, given local economic and cultural realities.

We will install two belts on different cattle farms during the rainy season (between June and December) of 2012. Each belt will be at least five meters wide and one hundred meters long, and will allow landowners to continue to use their farms productively. Forest belt tree species will be selected for the direct additional benefits they provide for farmers.

During the year following installation, ROW will monitor and evaluate the belts' impact on reducing soil erosion and surface runoff, improving biodiversity.

Throughout the project, we will encourage other landowners to visit the pilot farms and explore the advantages of agroforestry. In addition, we will use data gathered from the two farms to promote the technology's benefits to all residents, including increased economic opportunities, a more sustainable and secure food system, and natural resource management that serves the best interests of the community.

Based on the project's success, ROW plans to scale-up the program, rolling it out to other Nandamojo farms. We will give priority to land that is strategically important for water resources in the area, which has been identified over the initial five years of ROW's work.

CONTEXT & LOCAL CHALLENGES

The Nandamojo Valley, a watershed of about 28,000 acres on the northern Pacific Coast of Costa Rica, is a diverse ecosystem containing dry tropical forests, open plains, streams and waterfalls, mangroves and beaches. It supports myriad plant and animal species, including howler monkeys, hundreds of species of migratory birds, and three endangered species of marine sea turtles. Life in the region is defined by alternating dry and wet seasons. Six months of rain, lasting from May to November, are followed by six months of drought, which is characteristic of the dry tropical forest. A biome that once stretched the entire length of Central America and into Mexico, the forest has now nearly been developed out of existence, with the largest remaining swath in Costa Rica.

Venerable long-time residents tell stories of the Nandamojo River flowing year-round within their lifetimes, and recount being able to rely on them for nourishment and irrigation even during the dry season. Most will also tell that their environment has undergone dramatic changes in the last several decades.

In the 1950s and 60s, massive swaths of the valley's forests were clear cut to create pastures for grazing cattle. This changed the landscape of the Nandamojo—thousands of acres of dry tropical forests were reduced to grasslands. Since then, a growing population and government land distribution programs have increased the amount of land cultivated, so that now many hillsides surrounding the valley have also been cleared.

In terms of the global consequences of climate change, "Agriculture is more worrisome [than energy]. Local water shortages will cause 'persistent irritation' — wars, famines," and soil erosion is "the biggest threat of all."

- *Jeremy Grantham in an article for the New York Times*

There are three core trends that have contributed to the degraded condition of the valley and dramatically altered the watershed's hydrology.

Deforestation: the multi-layered forests which used to cover the Nandamojo had served to slow, spread and infiltrate water during the rainy season, increasing the valley's capacity to absorb water. With the removal of forests, the watershed lost much of this capacity. More precipitation is leaving the valley as runoff, rather than infiltrating the soil and providing crucial groundwater during the dry season.

Cattle Grazing and Monoculture: for decades herds of cattle have grazed off the clear-cut pastureland, steadily compacting the top soil and removing nutrients and plant matter that would have decayed into new fertile soil. Changing agricultural practices reveal troubling evidence of a loss of soil fertility. Family farms are now completely reliant on chemical fertilizers for production, whereas only a generation ago most farmers cultivated corn and rice without adding anything to the soil. While the lack of crop rotation techniques is partially to blame, most farms are located on sloped land, and so erosion has played a significant role in this process.¹

Climate Change: the effect of the climate disruption occurring around the world has been to depress crop yields and amplify soil erosion; this ecological pattern is evident throughout the Nandamojo watershed and is greatly amplifying the anthropogenic damage. We observe three areas that are particularly susceptible to these negative impacts, which also have feasible solutions to mitigate the harmful effects:

- **The Nandamojo Aquifer**

Presently, the level of the valley's aquifer and its maximum sustainable yield are unknown, though there are projects underway to determine it. What we do know is that extensive, poorly managed pastureland has reduced the amount of percolation that is occurring. This problem is exacerbated by heavier downpours that do little to refill the aquifer, and instead sweep more of the soil away into the estuary and out to the ocean. Towns to the north are experiencing severe water shortages and have determined that the rate at which they have been drawing on their reserves has seriously depleted their aquifers.

Improving aquifer recharge will become increasingly important as studies indicate that Guanacaste will see a 13-24% decline in annual precipitation in coming decades.² It is important to implement practices that recharge the aquifer and reverse detrimental effects, allowing communities to build resilience.

- **The Estuary, Wetlands, and Beaches**

The Nandamojo's mangrove estuary, surrounding wetlands, and adjacent beaches are keys to a healthy and productive watershed. These valuable buffers are losing their capacity to shield the Nandamojo from storm-driven tides, hurricane strength winds and encroaching seawater, all of which are intensified by global warming. These areas must be bolstered immediately to prevent the contamination of drinking water and the further loss of flora and fauna. A recent flood, deemed to be the worst in over a century, provides further evidence that action must be taken.

¹ For a discussion of the effects slope have on rates of soil erosion, see: Montgomery. Dirt: The Erosion of Civilizations. Berkeley: University of California Press, 2008.

² Campos P, P. 2010. Assessment of decision-making made by livestock producers regarding adaptation strategies to climate change in Guanacaste, Costa Rica. Thesis, Mag. Sc. Turrialba, CR, CATIE. 79 p.

- **Food Production**

Climate disruption is affecting agriculture and food production on a global scale. Yields are declining,³ and intensified climate events such as droughts or floods are causing crop failures worldwide. Increasing production and availability of local food items will bolster the region's resilience and resourcefulness, and generate employment opportunities. This will help the community more capably adapt to challenges stemming from climate disasters, and improve their capacity to manage resource depletion.

As cattle ranching and monoculture still account for half of all land use in the valley, and form the basis for economic life for most residents, sustainable land use practices must be implemented within that system. Those practices should serve to prevent soil loss, improve water infiltration, and confront the problems presented by climate change.

SOLUTION: AGROFORESTRY BELTS

There are simple solutions that have environmental, economic and social returns. The approach ROW intends to test can be implemented with relative ease, will revitalize damaged land, and will allow valley residents to continue to use their land productively. Our aim is to support landowners in their transition away from damaging cattle farming to more diverse and profitable agriculture, while returning the dry tropical forest ecosystem to a healthy state. Installing agroforestry belts on watershed farms **will accomplish both of these objectives.**

The project is designed to provide maximum benefits for both landowners and the Nandamojo ecosystem. Whenever possible, the belts will connect to existing forests to create biological belts across farms, and will be planted along contour lines to enhance their effect in reducing erosion and runoff.

The environmental and ecological benefits of this kind of pasture restoration are optimal.⁴ The approach improves the infiltration of rainwater, extends habitat, and increases biological diversity of the watershed, among other benefits. Also, the forests break up the pastures, allowing better management of grazing land.

The economic benefits are diverse as well. Ranchers can elect to include *Moringa oleifera* in their forest, which has been proven to significantly increase beef and milk production⁵, or other species that will increase beef production by providing fodder during the dry season. Improved areas will be rich in diversity and may include fruit and nut-bearing species, which will benefit both landowners and the farmers they hire by diversifying income streams from their pastures.

³ IPCC, 2007: Climate Change 2007: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Parry, Martin L., Canziani, Osvaldo F., Palutikof, Jean P., van der Linden, Paul J., and Hanson, Clair E. (eds.)]. Cambridge University Press, Cambridge, United Kingdom, 1000 pp.

⁴ The benefits of using agro forestry systems instead of monoculture are widely documented. For one particularly relevant study, see: Current, D., & Scherr, S. J. (1995). *Farmer costs and benefits* from agroforestry and farm forestry projects in central america and the caribbean: implications for policy.* University of Minnesota, St. Paul, MN. Retrieved from <http://www.springerlink.com/content/v3207k3j2862m51w/fulltext.pdf>

⁵ Mathur, Babir (2006). *Moringa for Cattle Fodder and Plant Growth.* Trees for Life, Wichita, KS. Retrieved from [http://www.tfljournal.org/files/Moringa%20for%20fodder%20&%20spray%20\(screen\).pdf](http://www.tfljournal.org/files/Moringa%20for%20fodder%20&%20spray%20(screen).pdf)

Landowners who install agroforestry belts may choose to participate in ROW's complimentary initiatives. In particular, our [micro loan program](#) supports a variety of local, land-based enterprises that uphold sustainable land management practices. Project participants could collaborate with micro loan project partners by applying for interest-free loans to develop new businesses that fully utilize the belt. For example, beehives could be purchased and installed within the strip, or *Moringa oleifera* leaves could be integrated into a new poultry production enterprise.

With the installation of agroforestry belts, landowners will produce a wider variety of goods and the local economy will benefit. Vibrant, locally-based economies strengthen the social fabric of communities and improve resilience to a variety of potential systemic shocks. Also, generating new streams of income from land enables owners to avoid selling their primary form of wealth to developers. They can pass their most precious asset on to their children, creating future options for the region's youth.

Implementing this project has many peripheral advantages in addition to the direct impact. It will help Restoring Our Watershed and our partner organizations ramp up momentum for other watershed restoration activities such as the micro loan fund. Successful environmental initiatives will make the Nandamojo a more attractive place for visitors. This could represent substantial economic benefit to residents, as tourism is one of the fastest-growing industries in Costa Rica.⁶ A large portion of visitors come to this country because of its reputation for excellent environmental stewardship. Therefore, restorative efforts serve as an authentic marketing strategy for a primed market.

GOAL AND OBJECTIVES

ROW's mission is to restore the Nandamojo watershed's hydrology and reinvigorate sustainable, local food systems. For this project, our goal is to implement and popularize a proven technique for improving the land that 1) is widely accessible, and 2) motivates landowners to utilize sustainable practices. Agroforestry belts serve both our mission and project goals well.

The desired objectives of this project are as follows:

- By 2013, we will have established two agroforestry belts of at least 500 square meters each in the Nandamojo valley, developing a model that will be exported to other pastures in the watershed.
- From the installation of agroforestry belts in late 2012, and for twelve months thereafter, we will quantify and study the effects the belts have on land that is typical in the area. The information will be used both to validate the effects and to motivate other landowners to adopt the practice. We will have accurate, comparative data showing the difference between treated and control areas with respect to erosion and surface runoff.
- By 2014, the improved land will serve as "demonstration farms," and between 50 and 100 landowners from the Nandamojo will have visited the farms to learn about the reforestation belts and their benefits.

⁶ José Enrique Rojas (2004-12-29). "Turismo, principal motor de la economía durante el 2004" (in Spanish). La Nación. Retrieved 2011-10-29.

PROJECT DESIGN

We will select two sites from different parts of the watershed to serve as “demonstration farms.” Farms will be selected in the hilly areas surrounding the valley, where they will have the most impact in reducing surface runoff and erosion.

Reforestation belts will be 100 meters long and at least 5 meters wide. They will be planted along contour lines, and will be fenced in to prevent cows and horses from trampling plants. However, the belts will be accessible to migratory birds, monkeys and other beneficial species.

To be able to gather comparative data, monitoring will take place along a 200 meter strip, which will include a 100 meter belt and 100 meters of a control area. Installation will take place during the rainy season of 2012, beginning in June and aiming to finish by September. Over the next twelve months we will monitor and evaluate their impact.

The species used in the belts will depend on the needs of the landowners, who will be included in the design and installation process. Those who need fruits or nuts to supplement their diet and income will have the opportunity to include those species in their belt. Other options include species that provide more forage during Costa Rica’s dry season, and we will help them find the appropriate plants for their conditions. Our model strives to build a community’s capacity to manage natural resources in strategic, sustainable and productive ways.

Vetiver grass (*Crypsopogon zizanioides*) and piñuelas (*Bromelia penguin*) will be planted along the flanks of the belt to control erosion and form an animal barrier. Within the belt, we will plant a multi-level forest consisting of three lines of trees. Some species which will be used for the following purposes include (but are not limited to):

Lumber species for High canopy:

Guanacaste, *Enterolobium cyclocarpum*
Laurel, *Cordia alliodora*
Raintree, Cenizaro, *Pithecellobium saman*
Corteza Amarilla, *Roble Sabana*, *Tabebuia* spp.

Live fence posts:

Madero Negro, *Gliricidia sepium*
Indio Desnudo, *Bursera simaruba*
Pochote, *Bombacopsis quinata*

Forage species

Guacimo, *Guazuma ulmifolia*
Horseradish tree, *Moringa*, *Moringa oleifera*
King or Elephant grass, *Pennisetum purpureum*

Fruits/nuts

Nispero, *Manilkara zapota*
Maya nut/Ojoche, *Brosimum alicastrum*
Cashew/Marañón, *Anacardium occidentale*
Coyol palm, *Acrocomia vinifera*



EXPANDING OUR VISION: TAKING THE MODEL TO SCALE

Restoring Our Watershed is striving to create a model for watershed restoration that is widely accessible and can be exported outside of the Nandamojo river valley. Agroforestry belts will be an important part of that model.

The use of agroforestry to revitalize pastureland is easily transferrable to other watersheds damaged by deforestation and cattle grazing. The potential of this technique is not limited to our region or even Costa Rica; it can be adapted to serve the needs of landowners in many parts of the world. Moreover, there are an infinite number of ecosystems which have been degraded due to poor land use practices such as clear-cutting. As wet-dry tropics have been designated one of the most endangered ecosystems worldwide,⁷ this work is all the more important. **We are solving a common, urgent problem using a flexible solution.**

ROW'S CAPACITY

Restoring Our Watershed has been active in the Nandamojo for over a decade. During that time, our staff has gained a profound understanding of the valley's culture, its history, and the most pressing problems facing its residents. ROW leadership has developed invaluable relationships with local farmers, community business leaders. Those relationships give our organization the strength and credibility to help them tackle these problems.

ROW repeatedly demonstrates an ability to successfully plan and execute meaningful projects, which are described below. Moreover, ROW has established a strong, community-based Costa Rican counterpart, the Pro-Watershed Ecological Blue Flag committee (Comité pro-cuenca de Bandera Azul Ecológica). The committee is made up of representatives from all of the watershed's villages, and will collaborate with this project by coordinating visits to the demonstration sites, volunteer labor, and promoting the initiative within the valley.

Previously, ROW planned and implemented the Nandavi Project, which was funded through a United States Fish & Wildlife Service grant. The project focused on three areas: 1) Surveying avian species present in the watershed, with emphasis on known migratory species which over winter here. 2) Establishing the relationship between remnant riparian forest and the diversity of avian habitat. 3) Beginning awareness-building regarding the links between habitat conservation and restoration and the hydrological balance of our aquifer.

Some other projects that ROW has already completed include:

- Initiated the systematic collection of rainfall and runoff data, starting in 2004.
- Conducted territorial land-use planning workshops in several towns within the watershed.
- Spearheaded the confederation of Asadas (Community Water Boards) and held workshops on the importance of a "watershed-wide" effort.
- Organized river cleanup campaigns.
- Collaborated in providing 75% of trees for a native species reforestation campaign. Thousands of trees have been planted by hundreds of volunteers in riparian buffer zones, along denuded coastal strands and in vital recharge zones.
- Within collaborating residential developments, seasonal ponds have been established for waterfowl, and other erosion and runoff techniques have been employed to ensure habitat connectivity and create positive impacts on water quality and aquatic habitat.

⁷ Janzen, D.H. Management of habitat fragments in a tropical dry forest growth. *Annals of the Missouri Botanical Garden* 75(1): 105-116.

- Assembled Database of SIG information on the watershed.
- Conducted baseline field surveys and launched proposal for a biological belt between the Junquillal mangrove and 600 acre Venado forest preserve.
- Ongoing collaboration with ecological groups in the watershed, including Proyecto Baulas del Pacifico (Junquillal sea turtle project) and the mangrove protection effort organized by the Assn. de Desarrollo de Junquillal.
- Organized and trained a volunteer fire control brigade within the valley.

PARTNERS

ROW's implementing partners for this project are El Centro Verde and the Comité pro-cuenca de Bandera Azul Ecológica (CPC).

El Centro Verde (ECV) is an institute founded in 1996 by Tom Peifer, an agroecologist, writer and builder. Peifer created ECV to teach and inspire ecological literacy and sustainable solutions to the next generation of earth stewards. He has transformed the once seasonal pasture and spiny jungle thicket to a sustainable farm, research facility, and educational institute. Over two decades ECV has tested and developed methods around managing farm and forest lands to maximize soil nutrients, and optimize local, renewable resources. The institute strives to integrate agricultural, environmental, educational considerations into its programs and services to support sustainable community development.

The institute will be providing technical expertise for the project, especially relating to layout, transplanting, arrangement of plants in the belts, and species selection.

The Comité pro-cuenca de Bandera Azul Ecológica (CPC) was formed in 2011, with the support of ROW's leadership, in order to establish a local, watershed-level environmental organization. The group is part of the national Blue Flag program, which was created to incentivize the protection of water. Their work centers on developing and implementing projects to address watershed problems, such as contamination or deforestation.

The committee will play an instrumental role in bringing other landowners to see the reforestation belts and promoting their benefits throughout the watershed. Their membership is comprised of ten people from villages in the Nandamojo, so they are easily able to disseminate information to most residents.

PROGRAM BUDGET

Agroforestry Belt Project Budget - SUMMARY	
Project Term (18 months): April 2012 - September 2014	
Line Item	Cost in USD
Personnel (33% time Program Manager, one technical and implementation consultant and three installation consultants)	\$16,795
Materials (covering two 500sq. mt. belts)	\$4,304
Transportation (to and from belt sites, including bus rental for local outreach)	\$4,042
Administrative (office costs, logistics, communications & supplies, etc)	\$2,652
Subtotal	\$27,793
Committed Funds (funds committed from existing ROW donors)	\$15,527
TOTAL	\$12,266

Budget Narrative

The \$27,793 total budget reflects all expenses associated with implementing this project. Existing ROW donors have committed to funding all indirect and overhead expenses, as well as a portion of the Personnel allocation. A full 100% of additional funds we raise for this project will go directly to project implementation and purchasing materials.